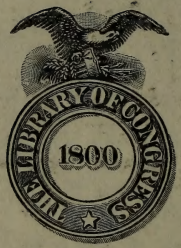

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THE WONDERS OF THE UNIVERSE,

WHAT SCIENCE SAYS OF GOD.

SIGNS, SIGNALS, SYMBOLS SELDOM SEEN, SCIENCE SAYS SING SILENT SONGS OF THE GLORY OF

THE MAKER OF FIVE HUNDRED MILLION SUNS

THE SCIENTIFIC DISCOVERIES OF OUR DAYS IN THE LANGUAGE OF THE PEOPLE.

I. The Wonders of The Heavens.
II. The Wonders of The Solar System.
III. The Wonders of The Earth.
IV. The Wonders of Life.
V. The Wonders of Human Life.

BY

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Member of the Association for the Advancement of Science. President of the Christian Press Association.

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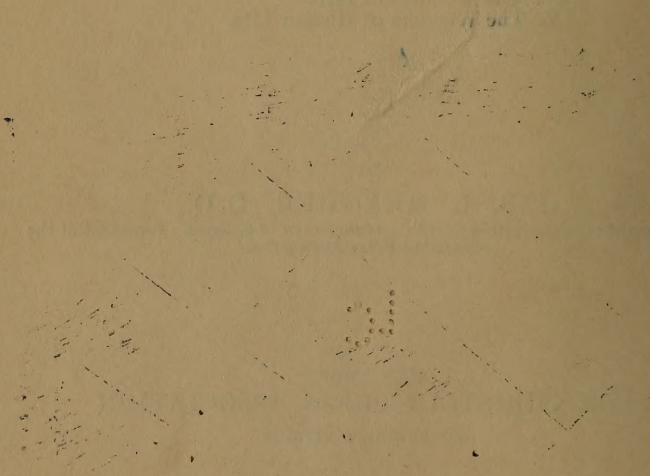

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CORRECTIONS.

After correcting and returning printer's proofs, I was called away for months, the typesetter neglected to make the corrections, and in the mean time the book was printed with a few mistakes in English and composition which do not affect the meanings.

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24	19	the	The
32	12	reveal	Reveals
43	36	their	the
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131	12	the then earth	then the earth
142	24	which	who
164	1	JUIPTER	JUPITER
168	33	crack	cracks
172	27	measures	measure
178	30	falls	fall
180	32	specra	spectra
180	32	he	the
189	1	then	there
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268	20	reflect	reflects
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311	22	feet	miles
314	19	cools	cool
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A "CRANK" IN THE NATIONAL OBSERVATORY.

THE trolley stopped at a gate on the right leading into the grounds of the National Observatory on Georgetown Heights, near Washington, D. C. Going down the walk a fine-looking, well-dressed, intelligent appearing man caught up. After a pleasant greeting the writer said:

"Yes, I am going to visit the Observatory. The Government made a nice walk leading down through this shady valley and up the hill opposite to the buildings."

"You are mistaken, sir, no one built this walk. It came by evolution, or by chance. There is no such thing as cause and effect. I never believe what I don't see. Did I ever see my liver? Well, no. But I suppose I have one, as all men have."

At first I supposed he was joking, but soon found he was very much in earnest, and, supposing he was a harmless lunatic, I humored him and we talked as we went up the hill. On the hill were quite a number of buildings devoted to the sciences relative to astronomy.

"They have a large number of buildings and the Government spent a lot of money here. This institution is famed throughout the world. I wonder who was the architect and what they cost.

"There was no architect. These buildings just got their materials together by chance."

At our left on the hill towered a large domed building inclosing the great 26-inch equatorial telescope. Finding the attendant we went in, and just under the dome was the great tube, upheld by a pier coming up from the rock far beneath, so as to be free from any vibrations. The room was about 75 feet in diameter, the dome rest-

ing on iron wheels running on tracks, so the whole dome could be turned to point the telescope to any part of the heavens, through a shutter running down from the top to the spring of the arc. The shutters could be closed or opened at will. As the great telescope is pointed to a star high in the heavens or low down near the horizon, the floor can be raised or lowered by hydraulic pressure, a system of water-pipes serving for that purpose. Every science, art and mechanical contrivance known to man had been used in making this instrument. An iron staircase led up to the great instrument, and the writer went up and examined the details. A description of the instrument, the greatest in the world when built, would take up too much space.

"It is very fine," said the writer. "The Government spared no cost in its construction. Who built it? I suppose the greatest cost was in the making, grinding and polishing the 26-inch objective glass?"

"You are mistaken," said the man, "it was never made. This whole instrument came by accident. All parts of this delicate machinery just happened to arrange themselves together, and then got up on to that stone pier."

The attendant looked at him in astonishment, while the writer winked at him.

"Who is he? a friend of yours? No? You only met him on the sidewalk coming in the grounds! I suppose he is only a harmless lunatic. It is better to humor him, for if we oppose him he might become dangerous."

We went into another building where a smaller instrument was placed exactly north and south in the longitude of Washington. Looking through this great telescope you see 12 silvery lines straight up and down with another in the center crossing at right angles. Observing a star, you let it run along the central bright line from east to west. As it strikes a line up and down, you press an electric button, and the electricity marks the exact time the star passes that line. Doing this when the star passes 9 lines, you add up the figures

and this divided by 9 gives the exact time when the star passes the meridian of Washington. The bright lines are fine spider webs, and to put them in the field of the telescope is quite an art. You first get a little stick of wood which is just heavy enough to break the webs, then split it in halves and use one half to stretch the webs.

The machinery to move the telescope is elaborate and delicate, over which the observer, lying on a movable couch, has full control, who with a touch sets the apparatus and great tube in motion.

A visitor remarked, "What science and mechanical art were required to construct such an instrument! Who made it?"

"No one made it," said the man, "it came by chance. It was always here. Nothing was ever made by any one. Things were always as they are now. There are no such things as cause and effect. Instruments as well as stars, sun, and planets were always."

Smiles went round. We went into a neighboring building where the time of the passage of the stars is recorded by the electric current. A sheet of paper, ruled into 60 spaces, is rolled round a cylinder, which turns in 1 minute, having a governor like a little fly-wheel. A steel wire, bent like a fishhook, rises when the cylinder turns too fast, and its point strikes the spokes of the rapidly turning governing wheel, so as to retard its velocity, thus making the cylinder with the ruled paper make a revolution in exactly 60 seconds.

As the astronomer presses the electric button the moment a star crosses a spider web in the telescope, an armature raises a pen filled with ink pressing on the paper, and that makes a V between the lines on the paper. The spaces on the paper being nearly 1 inch apart with divisions of seconds, the time of the passage is given to minute divisions of seconds. We talked about the ingenuity of the man who invented this method of recording the time of the passage of the stars, when the stranger remarked:

"I tell you this machine was never invented. All

you people are mistaken. It just happened to come that way."

We went into smaller buildings where the stars are photographed, and this man held to his theory that the photographic instruments were not made. We examined the clocks, and were especially interested in the main Time Clock, of which they have two. One is down about 15 feet below the surface of the earth, and is seldom visited lest the heat of the body might change the rate, even while standing beside it, for a few minutes. The other is in the office of the superintendent.

Two glasses, each as large as a half barrel and dome-shaped, are hermetically united at their edges, so that no air can penetrate. The clock-works are in the upper glass, and the pendulum, beating seconds, swings down in the lower glass. Through the lower glass are two holes, electric wires passing through them. The electricity winds up the clock every five seconds, and a gravity escapement bears on the spring of the pendulum at each beat. A barometer shows the pressure of the air within the united sealed glass globes, and when the pressure changes, the barometer within showing this, the air is pumped out through a hole with an air-pump similar to those used for bicycles.

"This," said the superintendent, "was made in Germany, and is a recently invented clock. They are very costly and are found only at observatories." The man again protested they were never invented by any one, but we paid no heed to him, the writer having given a hint to the superintendent.

Near by were the series of instruments which each day at noon send out the exact time over the wires to every town and city of the United States. The man protested these were never made. In another part of the room were cases holding hundreds of chronometers, sent there from different naval vessels to be tested, and their rates determined in various degrees of heat, as the place of the vessel at sea is found by the time given by the ship's chronometers. The man noisily declaimed

no one made these timepieces. He held that all these wheels, balance springs, main-springs, pivots, pinions, etc., of these timepieces just came together by accident.

We looked over the great library, mostly relating to astronomy and the sciences. The books were in different languages—English works prevailing. The man argued that no one wrote these books. The letters just happened to get mixed up and fell together that way, the pages came out all right, and accidentally the covers got put on. We had gotten used to him and looked on him as a fool or one who had lost his mind.

The writer remarked, "What must be the power of God to make so many stars, and swing them in their orbits!" The man got furious. With vehemence he shouted:

"There is no God. The universe was always here. The stars and matter and the world are eternal. The belief in God is only a superstition which came down from days of ignorance. What fools people are to believe in a Supreme Being. I believe only in what I see. No priest or minister can fool me. I did not see these great telescopes and instruments the United States Government sent and put here, made; and I do not believe they were ever made. I did not see the millions of suns and stars created, and I will never believe they were made. I never saw God, and until I do I will not believe in Him. This is an age of enlightenment. It is time to throw overboard the religious superstitions of the ages of ignorance. All things came by evolution, by chance, or in some other way. But no God made the world, it always was and always will be. Science proves there is no God. I have read all the scientific books, and these learned writers prove there is a continual conflict between science and religion, which will never stop till one or the other will be driven from the field. When science proves there is a God, I will believe in Him and not before. You can't fool me with your nonsense about religion."

He walked away in triumph, feeling he had gained a

victory over us all. Quite a crowd had gathered by this time, for many people had joined our party

"What an awful crank he is," said a lady. "I believe in God, because my heart tells me He exists. I don't reject the promptings of that sentiment of nature. I think it must be sin and all kinds of wickedness which wipe out the image of the Creator from any human heart."

"I believe in God," said one of the astronomers, "because we see His works in the stars, in the mechanics of the heavens, in the mathematics ruling every orb in the sky. There must have been some infinitely wise Cause who marked the revolutions of the heavens. Some Power weighed every body floating in the sky, and put each star where we find it, revolving round its primary, otherwise chaos and anarchy would reign. This man must be insane if he is really in earnest. But we have to put up with some peculiar people, who come here, each with a 'bug' in his head."

"I am a professor of chemistry in a university," said another. "I find every metal and element in their different unions and combinations take forms according to mathematical formulas, which can never be changed. The elements unite or dissolve according to figures. Mathematics rule all materials. Who laid down these figures for nature? We did not. They were there before we discovered them. The one who denies there is a thinking Power behind nature, or says that the universe came by chance or by evolution without a directing Mind, is as big a fool as that man who just now held that these buildings and the great instruments of this observatory came together and formed themselves as we see them now. To one who stops to think of the harmony and beauty of nature the thought forces itself into his mind that a Being infinite in wisdom made this universe."

"I am a lawyer," said another man. "In our courts we swear witnesses on the Bible. Without the thought of God and the life beyond the grave, it would be im-

possible to have order in society. The civil law is imperfect without the laws of religion. The American people are religious at heart. I don't care whether a person belongs to the Christian, Jewish or any other faith; our government fosters and protects the members of all religions. But I know from my own experience that without the belief in God, life, liberty, and the pursuit of happiness on which our free system rests, would soon vanish. In the last century the French people drifted into infidelity, denied God, and the revolution came as a consequence. Blood, carnage, murders, robberies, swept over the land and all Europe felt it. Will these horrors deluge our land in blood? They will if religion dies out."

Turning to the writer, he said: "I think you are a clergyman from your dress, would you be so kind as to give us the proofs of the existence of God from your point of view?"

"Ladies and gentlemen, I cannot give you the reasons why we believe in a Supreme Being in a few words. Learned men wrote books on that subject which would fill a large library. The belief in God comes down to us in all the nations. Years ago I wrote a work, "The Religions of the World," showing that every nation, tribe and tongue believe in God—in a Supreme Being under different names. No nation can exist any length of time without that idea, for men would rob, kill and fight each other till the whole people would die out."

"Many able thinkers say the idea of a Supreme Being is born with each one, and develops with reason. We cannot see Him with our senses as we see the sun and the world round us, for He is a Spirit. But the wonders of the universe prove a Maker as the works of man show workmen made them.

"'The heavens show forth the glory of God and the firmament declareth the work of his hands.' (Ps. xviii. 1). You astronomers who search out the wonders of the stears know this. 'For by the greatness and the beauty and of the creature the Creator of them may be

seen.' (Wisdom xiii. 5). 'For the invisible things of him from the creation of the world are clearly seen, being understood by the things that are made, his eternal power also and divinity; so that they are inexcusable' (Rom. i. 20).

"Two causes, sin and ignorance, make a few men talk as that man did. The wicked do not want to believe in God because they fear His judgment after death. Children and women nearly always believe because they are innocent. Few people know all the sciences, hence they do not know the wonders of the universe.

"Everywhere in heaven and on earth we find laws, mathematics, mechanics, and matchless arts and sciences ruling all nature, from the tiniest grain of sand to the mightiest sun. How did this universe with all these perfections get together and get going? A machine must be invented, sky-scrapers must be constructed, a battle-ship must be built—all human works and industries must be directed by human reason. Who but the fool will hold that this universe with all its matchless forms of beauty and machinery we see in the orbs, on earth, in bones, muscles, nerves, and in plants, came together by evolution, by haphazard, or that blind unthinking nature made them? The very idea is unthinkable to any learned person.

"Things can be made only by a thinking person. Only a personal thinking God, having a mind and free will could plan the universe.

"This universe is one complete whole and its parts depend one on the others. Scientific men devote their time to the study of separate parts of the universe, hence their knowledge is one-sided, few go over the whole domain of the sciences. We should have a full knowledge of the natural sciences so we can see the whole in all its parts, one branching into and dovetailing into the others. Then we can see what God hath wrought in nature. Having all perfections in Himself, for He is the infinite Perfect Being, He could not make

a thing with a perfection he had not, for then He would not be perfect. Therefore we must keep before our mind that what we find in nature, this also is found infinite in Him."

Come with me, gentle reader, while I give a Summary of the Sciences. Let me tell you what modern science and discovery of our days says of the vast plans of the universe. We will leave out all hard words and scientific terms so the simple-minded will understand without an effort.

We will see how God brought matter from nothing as fine dust, metallic fogs, floating particles, spread throughout space. We will see these formless, dark, motionless metals received movement and weight to fall by attraction to form mighty suns and planets as now we find them in the sky. We will see how our sun and his planets were made. We will see how our earth was prepared for living beings before man appeared. We will give a rapid glance at the different kinds of plants and animals. We will look at the theory of evolution. Then we will see how God made you and me in that little living cradle of flesh, blood and nerves, where our parents placed us before we were born into this world.

In our day the knowledge of God is getting weaker in human hearts. Ignorant infidels deny the very existence of God, saying science proves no future life—no Supreme Being. Hence, crimes, murders, suicides, divorce, and all kinds of wickedness are inccasing all over the world. The world quoting the discoveries of science against religion is drifting to infidelity. Let us see what science, rightly understood, says of God.

SECTION I.—THE WONDERS OF THE HEAVENS.

CHAPTER I.—THE FOUNDATIONS OF THE UNIVERSE.

Go out at night, when the stars shine bright, and look up at the heavens. A ring of light at a vast height sweeps round amid the stars. A great half-circle it seems in our northern latitude, its two ends lost below the horizon. Go south, below the equator, and you find it forms a mighty white cloudy ribbon, running round the whole heavens. It inclines at an angle of 63 degrees to the equinoctial, that imaginary plane where the sun is when days and nights are equal.

From far-off days, when our race was young, men asked: What is it? Because of its whiteness, the Greeks called it the Galaxy, from gala, "milk," and we the Milky Way. Sweeping round the whole firmament, as a mighty ring, looking like a bright, long, white expanse with irregular borders, nowhere broken, it ever excited curiosity, and claimed the study of the world's greatest minds.

All was guesswork till the telescope was invented. the two Herschels, Sir William and Sir John, father and son, using the most powerful instruments known in their days, spent almost their whole lives in its study. The greatest astronomers of all ages, in every civilized country, tried to penetrate its mysteries and in few words we will lay before the reader the sum total of their labors. How can we make the reader grasp the wonders our instruments reveal, when so many learned men have spent their whole lives studying the heavens? how will we condense their discoveries into a few pages?

O, the power of the Almighty! The Milky Way with its millions of orbs, the amount of matter they contain, the fiery forces sporting in these mighty suns, the awful distances separating them, their weight ever keeping them together, the circular movements holding them in their orbits, the wonders we see up there in the sky—all these press in on us and stupefy the mind overpowered with the unthinkable power of the Eternal. We can only in a general and vague way make others see what we find, for no words can convey the full meanings of the lessons of the skies.

The 'wildered mind is tossed and lost,
O heavens, in thy eternal tide.
The reeling brain essays in vain,
O stars, to grasp your vastness wide.
A terrible, tremendous scheme
Glitters in each glancing beam.
O stars, too rudely jars the night
To tell all glories of the Infinite.

Who is man and what his place?
Anxious asks the heart perplexed;
In this awful recklessness of space,
Worlds with worlds thus intermixed,
Have other orbs like ours a race
Like us to this earth fixed?

Let us give a rapid glance at that great Galaxy. To the naked eye it seems a vast wheel of light, a magnificent arch of white diffused cloud, spanning the heavens like half a circle in our hemisphere, but it continues south till we find it a white wheel round the sky. In detail it is very irregular, sometimes seen as a single ring, oft it doubles; in places, again, parts are dark rifts, bright spots, dim patches—these never change, as we follow along its mighty circle with the naked eye, to which it appears as though made of white, cloudy mists.

Turn a small telescope to it, and great numbers of stars appear, unseen to naked eye. Use a glass of higher powers, and thousands and thousands of stars appear.

Look through one of the great telescopes of our observatories, and you find the whole Galaxy densely filled—fairly packed with stars. They are in some places ranged in circles in wavy streams, in lace-like forms, in dark rifts, in bright bands with groves and spots, in spirals—in every conceivable groupings, oft with bright clouds beyond, which higher powers show to be stars. Beyond the Milky Way there is nothing but the inky blackness of utter nothingness. Within this circle of stars we call the Milky Way are the stars and constellations twinkling every bright night.

It would be useless to give in miles the distance to the Milky Way, for the bewildered mind could grasp but dimly the tremendous spaces separating us. The figures would be simply overpowering. We will therefore give its distance in the time light takes to come from these suns to us.

Let us recall: Light sweeps with the swiftness of 186,000 miles a second, a million miles in about 5 1-2 seconds, taking 8 minutes from sun to earth, through the 92,900,000 miles separating us, and 400 years from the star Alpha Argus, near the Milky Way. But from stars on the near borders of this ring light is 500 years on its flight before flowing in on our shores of vision, while the rays of light from the outer borders of the Galaxy have been on their journey 1,800 years before reaching earth.

Reader, stop to think of the vastness of the material creation! When you look at the farthest stars of this great Galaxy, the Milky Way, the light with which you see them swept out from these suns in the days when the Roman empire was putting Christians to death. While it was on its way rushing with that almost inconceivable rapidity the mighty movements of mankind took place; the Middle Ages passed, the developments of modern times began, the sciences were born, rose and developed, the landmarks of the ancient world were swept away, and modern civilization began. The human mind

is lost and tossed in trying to grasp these distances. Light takes 3,600 years to pass from one border of the Galaxy to the other, across through the center of the universe.

Now let us see through the telescope, more in detail, this mighty ring in its relation to the rest of the stars. On a clear cloudless night the scene is inexpressibly grand. Sirius, Capella, Vega, and other stars of the first magnitude, groups of stars as Orion, the Great Bear, the Little Bear, Cassiopia, the Pleiades and other constellations, are near the Galaxy. Over your head, to the north, or in the spaces between, are the best known constellations, while the fields of the sky on all sides, from the zenith to the horizon, are filled with less brilliant points of twinkling lights. Scintillating traceries, formed of stars of all magnitudes, are scattered in bewildering numbers along the borders of the Milky Way. They are so numerous you cannot count them or resolve them into any systematic order. The sight of the shining suns seen through a large telescope is so grand, so striking, we wonder not the ancients, in their child-like simplicity, worshipped them.

A view of any part of the Milky Way through a great telescope is magnificent—surpassing. The whole field of vision is filled with stars, some larger, some smaller. Cover the window of a room with thick paper so as to exclude all light, then with a pin pick little holes in this paper so as to let in the light, put the holes as closely together as the paper will stand without tearing. Then let the sun shine through these holes into the dark room, and you will get an idea of the Galaxy seen through an observatory telescope. In some places the stars are so close as to be almost touching, while in other regions they are farther apart. They are not near, but one is billions of miles beyond the other. Near the Southern Cross is a space, nearly oval, where there are few stars, it is called the "Coal Black Hole." Beyond it is the inky

black of nothingness and everlasting night. Above it, a little to your right, is a bright nebula.

The relations of this great belt of telescopic stars to the rest of the stars, especially to our earth and sun with his planets, long occupied learned men. From whatever side it was approached, the number of stars rapidly increased as the power of the telescope developed. The form was found to be like that of a flat disk of suns, a vast round wheel, grindstone-shaped, of different thickness but split into two streams on one side, where it appears double, edges touching.

The brilliant spots and patches, the dark rifts and openings, the narrow streams of light and rifts, often bounded by equally narrow streams of darkness, showed it to be a tremendous ring filled with and formed of stars. All studies on the subject prove the Milky Way a vast irregular ring of stars with narrow rifts or openings encircling the whole of God's creation. It is as it were the nuptial ring of the Eternal with his material creation. Beyond it there is nothing.

Sir John Herschel, following the example of his father, Sir William, spent almost his whole life in its study, both in the northern and southern parts of the earth, using the most powerful instruments then known to mankind. After describing how the great ring passes through the different constellations, Sir John continues:

"When examined with powerful telescopes, the constitution of this wonderful zone is found to be no less varied than its aspect to the naked eye is irregular. In some regions, the stars of which it is composed are scattered with remarkable uniformity over immense tracts, while in others the irregularity of their distribution is quite as striking, exhibiting a rapid succession of closely clustering rich patches separated by comparatively poor intervals, and, indeed, in some instances, absolutely dark, and completely void of any star, even of the smallest telescopic magnitude. In some places not more than 40 or 50 stars on an average occur in a gauge

field of 15 degrees, while in others a similar average gives a result of 400 or 500.

"Nor is less variety observable in the character of its different regions, in respect to the magnitude of the stars they exhibit, and the proportionate number of the larger and smaller magnitudes associated together, than in respect of their aggregate numbers. In some, for instance, extremely minute stars occur in numbers so moderate as to lead us irresistibly to the conclusion, that in these regions we see *fairly through* the starry stratum, since it is impossible otherwise that the numbers of the smaller magnitude should go on continually increasing *ad infinitum*. In such cases, moreover, the ground of the heavens is for the most part perfectly dark, which again would not be the case if innumerable multitudes of stars, too minute to be individually discernible, existed beyond.

"In other regions we are presented with the phenomenon of an almost uniform degree of brightness of the individual stars, accompanied with a very even brightness of the individual stars, with a very even distribution of them over the ground of the heavens, both the larger and smaller magnitudes being strikingly deficient. In such cases it is equally impossible not to perceive that we are looking through a sheet of stars nearly of a size and of no great thickness compared to the distance which separates them from us. Were it otherwise, we should be driven to suppose the more distant stars uniformly the larger, so as to compensate by their greater intrinsic brightness for their greater distance, a supposition contrary to all probability . . . .

"Throughout by far the larger portion of the extent of the Milky Way in both hemispheres, the general blackness of the ground of the heavens on which its stars are projected, and the absence of that innumerable multitude of excessive crowding of stars of smallest visible magnitudes, and of the glare produced by the aggregate of light of multitudes too small to affect the eye singly,

must, we think, be considered unequivocal indications that its dimensions in *directions where these condition obtain* are not only not infinite, but that the space-penetrating power of our telescopes suffices to pierce through and beyond it."

In the above quotations the italics are those of Sir John Herschel himself. The investigations of learned men who came after him show the number and extent of the stars are not infinite, and that the material universe is bounded. In a footnote he concludes his studies of the Milky Way with these words: "This circle is to the sidereal, what the invariable ecliptic is to planetary astronomy—a plane of ultimate reference, the ground-plane of the sidereal system. (Footnote, p. 575, 5th ed.)

The Milky Way is therefore the groundwork of the universe, upholding the whole heavens. This vast ring of stars surrounds the whole material universe. It embraces within itself all the visible world.

The whole vault of heaven appears to be thickly strewn with stars of different brightness. But when astronomers made a careful survey, they found the stars scattered very irregularly, but always more numerous near the Milky Way, which covers not more than one-seventh of the whole heavens. Gore found that of 32 bright stars, 12 lie in the Milky Way, and that out of a total of 5,356 stars of first brightness, 1,186 are in the Milky Way. Proctor counted 324,189 stars down to the 9th degree of brightness, two-thirds of which were in the Milky Way. Prof. Seeliger, of Munich, divided the heavens into nine regions; he gives the number of stars down to the ninth magnitude, and shows that from each pole, where they are less dense, they increase till you reach the Milky Way, where they are in proportion of 2 to 8 in numbers, and Prof. Newcomb remarks: "The conclusion to be drawn is a fundamental one. The universe, at least the denser part of it, is really flattened between the galactic poles, as supposed by Herschel and Struve."

The material universe of stars has therefore the shape of a mighty double lens-like globe of orbs, so vast it takes light 3,600 years to cross it. Some writers say they are so far away, it takes 10,000, 20,000, 60,000 and 120,000 years for the light of these suns to reach us, but these are exaggerations. Recent studies with finer instruments prove the first figures correct, and that the universe is bounded by the Milky Way like a vast equator running round this tremendous globe of stars.

This Galaxy, like the outer rim of a magnifying glass, stretches out beyond the star-globe. We, on our little earth, are nearly in the middle of this wheel of stars, in what would be the hub of the wheel, and as we look up at the Milky Way its stars seem near each other, almost touching in some cases, to naked eye appearing as white clouds, because we look through from the center ont to the rim of the lens of stars. These orbs of the Milky Way seem so thick as to almost touch, because they are in line with us, and the stars being farther beyond. These stars are as far away from each other as the stars we see towards the north and south poles, that is trillions multiplied by trillions of miles. They appear to us as a ring somewhat like the rings of Saturn would seem if seen from the surface of that planet.

Let us now see what science says about the spaces within the Milky Way. On every side, to the north and to the south of the great ring, we see stars twinkling, scintillating as though living, they wink looking at us. This twinkling is caused by the air surrounding our earth through which their light passes before reaching the eye. Men who scale high mountains and go up in balloons to great heights, see the stars shining with steady light.

Some stars are quite bright, some dim, others—most of them—you can see only with a telescope, still other millions are caught with the photograph. The brightest are of the first magnitude, and they range down, ac-

cording to their brightness, from the first to the 17th magnitude. The stars are classed in these 17 magnitudes, according to their brightness. Many of the brightest have names given them by astronomers, but the others are known by Greek letters, numbers, or by their places in the constellations in which they are found.

There are clusters of stars, some seen with the naked eye seem like white clouds, which the instruments resolve into hundreds and even thousands of stars. The Pleiades, celebrated from most ancient times, have six stars seen by the unaided eye, but the telescope shows hundreds more, and the photograph exposed three hours reveal more than 2,000 separate stars. Præsepe, "The Beehive," in the constellation Cancer, is a cluster of stars, and there is another in the sword-handle of Perseus. In the southern hemisphere is found a hazy star of the fourth magnitude, about two thirds of the diameter of the moon. The telescope resolves it into almost countless stars of the 13th and 15th magnitudes, having rings of larger stars.

The suns thus scattered over the whole heavens are for the most part near or just within the Milky Way. They look as though no order reigned when they were thrown from the Almighty's hand. But when we make a careful study, we find order and regularity reign in heaven.

The law of matter forms orbs into round globes. This law prevails throughout the universe. Look at a globe representing the earth, and imagine it an abyss of deeps so great it takes light, flying 186,000 miles a second, 3,600 years to cross. Suppose that globe formed of ether we cannot see by any sense, which has only extension, does not prevent the orbs passing through it, which brings waves of light, heat, electricity, and numerous hidden rays from sun to sun and planet and earth.

This celestial globe, in size beyond the imagination, overpowering in extent, has a ring round its equator formed of millions of suns; this ring, or equator of

suns, we call the Milky Way. All through this clear crystal globe are suns, near the Milky Way they are thickly strewn, towards its poles they are found in groups we call the constellations. They are on its borders, on all parts of its surface, within and in all its parts. Among these you see white clouds in countless hordes; these are the nebulæ, systems of suns in process of formation. Nearly in the middle of this vast globe, in the hub of this wheel, the Milky Way, is our sun with its planets and our earth. Outside this tremendous globe of 500 million suns there is nothing. This hollow globe of stars, encircled by the Galaxy, holds all God's material creation. Our telescopes reveal, beyond its outside limits, the black nothingness of eternal night, as was before the Eternal said: "Let there be light."

First many supposed these millions of suns grouped into this vast globe formed a gigantic nebula, and that the nebulæ we see were other tremendous systems, in numbers and extent infinite, and that creation was boundless. The French use the word infinite in a reckless way, apply it to everything indefinite, or great, and from that much confusion rose regarding the stars. Recent observations by the best astronomers, with better constructed instruments, prove that all stars and nebulæ and every orb are within this mighty, hollow heavenly globe of matter encircled by the Galaxy.

The reader, therefore, can grasp in a vague way, God's plans, according to which he made matter. But the deeps, the abysses, the tremendous distances between the suns, the size of these orbs, are on such a gigantic scale that their full grandeur cannot be fully grasped. We have nothing on our little earth to serve as a measure.

But you ask: How can one man count these millions of orbs during his life, or measure these heights and deeps? About 30 years ago the different observatories divided the heavens into spaces, giving each institution a section of the heavenly vault and they set to work to count the stars of each allotted section as

printed on the photos. Professor Bernard's photos of the Milky Way show it is composed of over 500 millions of suns, so far away they make it look like white clouds, even the 40-inch refractor of the Lick Observatory does not resolve them all into points, but the photos bring them out, as shining suns.

The globe of stars, the universe the Milky Way encircles, is not exactly round, but like a thick lens. It is thicker from one side of the Milky Way to the other edge, the diameter through the poles, or at right angles to the Milky Way, being shorter. If the reader will imagine a globe of suns with very flattened poles, or a mighty lens of suns, he will get the general outlines of the universe. Every star is in motion, otherwise it would fall into some other star. Does this Galaxy roll round the heavens like a tremendous wheel? We do not know, for its movements to us so far away would seem so slow that millions of years would be required to measure it.

The rest of this star-globe is filled with suns but not so grouped and packed together as in the Milky Way, although they are millions in number. These stars are scattered all over the sky, from the Galaxy to the north and south poles, in groups the ancients called the constellations. Here and there among them are white clouds, millions in number, called the nebulæ. They are few in number near the Milky Way, but increase as you go towards the poles. They are like cloudy materials, star-mists, metals fine as flour condensing into and building suns.

In the very middle of this mighty wheel, the Galaxy, is a hub of stars, a globe of suns so great in size it takes light 600 years to cross. There are the stars we see with naked eye. They number nearly a million orbs grouped like a hollow shell inclosing another shell of stars having within another empty hollow space across which light passes in 300 years. Then comes in the center another empty globe, inclosing a vast space void of stars, having

in its center a still smaller globe of suns, a third globe in the very middle of the other two globes. This third globe is made up of the bright stars we see with the naked eye. They are the stars of which we have measured their distance, weight, times of revolution, and the materials of which they are composed. Down in almost the very center of these three concentric globes of stars is one star, the greatest, the hottest, the most mighty of the orbs. We call him Arcturus. Round this tremendous body rolls our small yellow sun, making his revolution in 100.50 years, dragging with him a host of planets—one of them we call the Earth, on which we live.

One of these planets, so small, so insignificant compared to other heavenly orbs, has an atmosphere nearly 100 miles high, great oceans, five continents, many islands and wonderfully balanced conditions of light, heat, gases, metals, etc. This little globe so small and insignificant, called the Earth, has what no other celestial globe possesses—beings which live. These organisms, or man, made of the same materials we find in the stars, have living principles with power of movement, propagate their species, grow, nourish themselves, then die. At the head of all earthly living beings is mankind, endowed with reason, image of the mighty Creator. Man is made in the likeness and image of the Eternal.

This cluster of stars, in the center of the universe, occupies about the tenth part of the inner shell or globe of suns. Within this little globe of stars the suns are very dense, or grouped together closely, compared with the rest of the universe. Not far from the outside of this round inner cluster of stars, revolves our sun round Arcturus near the center. This inner star globe, to which we belong, looks like the ring nebulæ of Lyra. Professor Newcomb gives a list of the 69 stars of which the movements are known, and 35 of them belong to this central globe forming the center of the universe to which our sun belongs.

Between this condensed cluster, the center of the universe and the Milky Way, above and below its plane to either pole of the Galaxy, the suns are thinly scattered, and there the nebulæ are numerous. There the force of gravity is a hundred times less than within this star cluster to which we belong, because the stars are so far apart compared to our central cluster, where they are so thickly grouped. Our sun is about 30 light years from the exact middle of the universe, the center of this inner cluster, to which it belongs, that is 190 billions of miles, 70,000 times the distance of Neptune from the sun. This gives us plenty of room to revolve round mighty Arcturus, placing us practically in the center of the whole material universe. Here we receive most of the light, and heat, and energy, and attraction, and invisible rays of the millions of suns round us required for life on our world.

The suns of our cluster drew in this floating matter; that is why these spaces round our central cluster are now more or less empty. Luigi d'Auria figured out these questions, and concluded that we are not in the exact center of the universe, but about 159 light years away. These are the latest discoveries, and they prove in the most astounding manner that the universe was made as given in Moses' words. Every advance we make shows these first chapters of the Bible founded on the most exact science.

Mr. Whittaker says that under gravitation and electric forces, most of the matter, which was made as fine dust scattered and diffused through space, flowed into the suns of the Milky Way, and into the great central clusters near us. The amount of materials now remaining between the stars being rather small, this explains the few and scattered suns we find within this central space. But all around and within, amid these millions of suns we call stars, as now we find them spread throughout this universe, reigned and ruled from the beginning, law, order and movement, directed by an indescribable

Power behind them, who made them and set them going as a piece of the most matchless machinery. All these millions of suns were made for the life which lives alone on this our little world. For this world, so small compared to these mighty suns, so tiny and so insignificant, alone of all the orbs, was covered with living beings for man, last of God's creations and most wonderful of all the mighty Creator made.

In the Milky Way, amid the constellations in the nebulæ, on all sides, our instruments reveal to us matter in process of formation into suns. The forces of gravitation, or weight, drag down materials. Light, heat and electricity, caused by gravitation, or weight, are in these places on a scale inexpressibly grand. Why was our sun with our little world placed here almost in the center of these three concentric globes of stars?

Here we see the design of the Eternal in his creative acts. These suns, forming these three globes outside us on every side, or grouped into the constellations eons of ages ago, gathered up the floating star-dust by their attraction, drew to them the rocks, the wandering bodies like mountains in size, little planets moving in spaces round them. Thus gravitation built the suns as now we see orbs being formed in the nebulæ. Therefore down in the center of the universe where we float with our sun and his planets, the orbs and suns have been built. Matter here, in star spaces near the universe's center, is stable, no great cataclysms, collisions of suns take place to destroy life.

Was there no design in this? Suppose these stars surrounding us had not in past epochs gathered up these wandering materials, the world would be bombarded with flying rocks sweeping down from the heavens, and their strokes would kill all that live on earth, heat our earth so hot it would shine like the sun. This is the reason these mighty suns were made to surround the space in which our earth and sun move. A wise Providence is shown here.

So far away are these mighty suns, we see them only as twinkling points of light. Some are much larger, others smaller than our sun. From deeps to greater deeps we pass, appalling in extent; even our greatest telescopes do not reveal a disk even of the greatest suns. Far out we look, beyond the farthest stars and nebulæ, out on the limits of the foundation ring, the Galaxy, out till at last we reach the limits of all created materials, suns, orbs, and then gaze into the dark empty realms of eternal night, without star-light. There reign nothingness and eternal gloom. Reader, raise your mind now to that Power who filled the heavens with suns as beacon-lights, and gave you a soul with powers to see them. Let us quote the words of Persia's great and ancient seer, Zoroaster, "The Living Star," found in the Sacred Books of India.

OF THE HEREAFTER.

Yet know, vain sceptics, know the Almighty's mind,
Who kindled in men a portion of his fire,
Bade his free soul nor earth nor time confined,
But to heaven, to immortality, to aspire.
Zoroaster, *Vendidad Forgard*, xviii.

Turn the great telescope of the Lick Observatory and look through the 40-inch lens. The clock-work keeps the instrument on any part of the heavens you wish. A thousand brilliant stars you could not see with naked eye flash into your field of vision. You are confused at their richness; in silence you admire the wonder. It seems a boundless ocean of scintillating lights, as farther and farther you penetrate what seems a boundless heaven of countless shining suns. Deserts follow deserts, where are no lights; new stars flash out—immensities follow immensities of stars. Clusters follow clusters, nebulæ give way to nebulæ, seemingly limitless spaces are beyond you still, filled with stars. You try to see each in turn, your mind stops thinking; your eye feels fatigue; your imagination stops; your spirit tells you these are suns, as faint you feel—powerless to

express the thought forced upon you. Who is God who made all these? Here are the footprints of Power infinite.

> Ye stars, bright legions that before all time
> Camped on yon plain of sapphire, who shall tell
> Your burning myriads but the eye of Him
> Who bade through heaven your golden chariots wheel.
> Yet who earth-born can see your hosts and not feel
> Immortal? Force gave you impulses from eternity.
> What wonder if the o'erwrought soul should feel
> With its own weight of thought, and the wild eye
> Sees within your tracks His glory doth now lie.

At your first glance infinite seems the numbers and systems of the stars. Are they infinite in numbers? That which is infinite is boundless in every way, has no imperfections of any kind. The infinite strictly belongs to God. If the universe was limitless in extent, space and perfection, it would be God. But in every part of nature we find imperfections. Nature was made with these imperfections, these defects, lest man might take it to be God and adore it. This idea, that nature is God, prevailed among the ancients, and was the foundation of paganism. It was revived in modern days under the name of pantheism. "All is God."—Spinosa's doctrine.

Is the universe limitless? The telescope shows that beyond the limits of the Milky Way, outside the stars forming the constellations, we find utter darkness. Recent discoveries prove the nebulæ to be within the great star-globe of which the Milky Way is the boundary. The old theory of a boundless universe has been proved false. The universe has its limits.

Studies of the last century, the observations of learned astronomers, the conclusions of all the scientists, show the stars, suns, nebulæ, comets, meteorites and heavenly bodies form one mighty system of matter the same in material of which our earth is made. The physical forces at work round us rule all heavenly bodies. The universe of material things is within that ring, the

Milky Way, at a distance which to us seems almost infinite. They show the power, the might of their Creator, who brought them forth from nothing, hung them on the law of weight or gravitation, and with a sweep of His infinite force sent them swinging round the heavens.

Even he who wrote to blot the idea of God from human hearts, Herbert Spencer, gives testimony to the unity of the universe as set forth so eloquently and so learnedly by the two Herschels. "If there were," he says, "but one nebula, it would be a curious coincidence, were this one nebula so placed in the distant regions of space, as to agree in direction with a starless spot in our own sidereal system. If there were but two nebulæ, and both were so placed, the coincidence would be excessively strange. What then shall we say on finding that there are thousands of nebulæ so placed? Shall we believe that in thousands of cases, these far-removed galaxies happen to agree in their visible positions with the thin places in our own Galaxy? Such a belief is impossible. In that zone of celestial space, where stars are excessively abundant, nebulæ are rare, while in the two opposite celestial spaces that are farthest removed from this zone, nebulæ are abundant. Scarcely any nebulæ lie near the plane of the Milky Way, and the great mass of them lie round the poles of the Milky Way. Can this also be mere coincidence? The proofs of a physical connection become overwhelming."

Ten or fifteen years later Proctor read his remarkable papers before the Royal Astronomical Societies from 1869 to 1875, in which he called the attention of the learned world to the fact of the unity of the material universe. From his time this principle has been accepted by almost every astronomer of the world. Thus when God made the universe, He made it as one mighty whole, composed and formed of less than a hundred different metals, which combining and uniting under their varied chemical and mechanical laws, make the

whole universe of matter. The grandeur, the marvel, the mystery of the Creator's works seen in science overwhelm us. We are like a child gathering pretty shells along the seashore, while the mighty unexplored ocean rolls its billows at our feet.

In all ages astronomers tried to find the limits of the material universe. They have now attained their goal. They have sounded the depths of the universe, and now they rest on their laurels. These men are worthy of all honors for the work they have done for humanity. Astronomers never fall into infidelity. I have never met one who did not believe in God, for they study His works on their grandest scale, they see the figures, the higher mathematics on which God founded the heavenly orbs, and they know a Mathematician infinite in wisdom was before them.

After defining the limits of creation astronomers set to work to fathom the nature of these suns, their materials, sizes, revolutions, weight, the amount of light and heat they produce, if they have any satellites, their growth and decay, their history in the past, their movements in the future—a thousand questions remain to be solved.

Let us see what cold science and everyday experience says. Put a marble, a stone, or any object in a place and it remains there; throw it in the air, it falls to earth by weight and remains there till some power outside itself moves it. When the orbs were made, if given only weight they would fall together. If they were thrown helter-skelter through the heavens they would wander like billiard balls on a table or fly up and down in all directions till they ran all over the heavens smashing, clashing, and chaos and anarchy would reign.

But every globe is moving. Where did they get this movement but from their primeval Mover, God? Will the fool say in his heart there is no God? But they move not in straight lines but in circles, in mathematical

curves. The paths of the suns are like railroad tracks stretching out, each of the tracks winding one into the other at their ends, a sun being in the center of one curve. The movements of every one of these million suns, planets, satellites, comets, asteroids, nebulæ, and heavenly bodies follow the departments of higher mathematics we call conic sections. Who shot forth from His Eternal canons these suns and orbs, to float forever in the heavens?

Millions of suns, far apart, sweep along these paths described in higher mathematics, shoot down like comets towards the other giant sun which holds each by its attraction. As they approach this other mightier sun the velocity increases, and they gyrate round with awful speed, as we see the comets sweep round the sun. Then the star or sun swings back like a pendulum, its motion decreasing as it gets farther away. The suns in their parabolic paths may come near other giant suns, and feeling the attraction of this new great body, they sweep round him and go off again on a new journey, perhaps to find in their course another sun round which to swing. Thus as time goes on, the millions and millions of suns swing round each other, one after the other, ticking out the time they measured from creation.

If these suns, or, as we call them, stars, had not these motions, or were not so exactly weighed, poised and sent in the right direction, anarchy would destroy the heavens. If they did not have just that exact movement they would strike together. Perhaps one would come into our solar system, strike the earth or our sun and overwhelm in a terrific cataclysm, the order of earth, sun, and our solar system. Who says there was not an overruling Power who gave these suns their weight, their direction, their velocity and the paths they follow lest the universe be destroyed?

The nineteenth Psalm, opening with the words: "The heavens show forth the glory of God, and the

firmament declareth the work of his hands," has been paraphrased as follows:

> " The spacious firmament on high,
> With all the blue ethereal sky,
> The spangled heavens, a shining frame,
> Their great Original proclaim.
> The unwearied sun from day to day,
> Doth his Creator's power display,
> And publishes to every land
> The work of an Almighty hand."

Wonders rise on wonders when we farther penetrate the skies. An astounding double drift of stars sweeps through the universe in opposite directions—millions of suns going one way, millions in the opposite direction, like a vast unnumbered crowd sweeping round two vortices. Recently this was discovered, and excites the attention of astronomers. Mind of man cannot think how long these double migrations of heavenly hosts have been going on: they were from dawn of creation, and will last as long as the universe, for it is the expression of a fundamental law.

On one side the Milky Way splits into two round leaves spread apart, on one side united together, on the other where these two tremendous turning star rings came together and mingled their millions of suns, each orb of one ring speeding in a direction opposite from those of the other celestial sphere. Yet these suns do not smash together, because the Creator foresaw and gave direction to the impulse when He sent matter into suns revolving on their axes and speeding round the heavens.

Two separate systems of suns have come together in the Milky Way, each retains its original movement of suns in opposite directions. The universe, made of millions of suns, first formed two Milky Ways, far separated, which came together by attraction of their orbs, each system keeping their opposite movements. Our sun and his planets were in one of the rings, near the center, down away from mighty movements of millions

of suns forming the tremendous rings. We are therefore down in the masses of stars, some moving to the right, the others to the left, yet never striking, for God marked out their paths.

Where the rings of stars united, the Milky Way is rich in stars; where the rings have not yet united, where their edges spread out, there the stars are not so numerous. When eons of ages, unthinkable years, come to pass, both rings will completely unite, fuse and all the suns will move in the same direction. The near-by stars only show movement, the suns on the outside borders of this mighty marriage of material creation will perhaps never be measured. For all we know, when the mingling is completed, the vitality of the starry universe will die, the gigantic system of nature will end, its fires will dim, its light will fade, its orbs will cool, its light and heat will end, its materials will remain, unless God will reduce all matter to nothingness and eternal night, from which He brought forth the universe by His might at creation. But as God works wthout repentance, all He made is good, perhaps He will let matter remain after ends our race, to show what He could do.

When we glance over the universe—over these millions and millions of suns—their numbers, hardly conceivable, press on the mind, and faint we feel as we think of their size, the awful grandeur and inexpressible power of the Creator of worlds and planets and mighty orbs. We ask the question: Is the system on which they are founded stable? Has heaven within itself the seeds of ruin and decay? Will a time come when these mighty orbs will fall together with a tremendous clash in which awful cataclysm all matter will condense into one globe of fiery material? Is this the end the seers of old foretold?

Astronomers with mathematical minds worked out this sum, and tell us the stars, subject to weight or gravitation alone, will go on forever. The universe has not within itself any force which will destroy it. From

the beginning the Eternal founded matter on mathematics, gave it motions and laws, and as long as these last the orbs will circle round and round. Only a direct act of the Almighty can take away weight and attraction which hold together the universe. Prof. George Darwin thus replies to these questions: "A symmetrical annular system of bodies might revolve in a circle with or without a central body. Such a system would be unstable. If the bodies are of unequal masses, and not symmetrically disposed, the break-up of the system would probably be more rapid than in the ideal case of symmetry. This would imply that the great ring of the Milky Way is unstable, but if this is so, it is a greater mystery than ever, for it has lasted from creation. We know of the existence of no great body, or vast central mass, which would attract smaller suns to fall into it."

Men who spent their lives examining this great Galaxy ring, say it is wonderfully symmetrical, and they assert the same of every star cluster. Whittaker says these suns are subject not only to weight, but also to electricity and electro-dynamical forces. Electricity is one of the great natural forces, and our sun is a vast source of electric energy. Men are coming to the conclusion that weight or gravity is not the only force to which the heavenly bodies are subject.

Newcomb figured out that in a universe of 100 million suns spread out over a space across which it would take light 30,000 years to pass, a star falling from its outer limits to the center would acquire a swiftness of 25 miles a second. Any body having a greater velocity, going in a straight line, would fly out into boundless space, far beyond the limits of the universe. Many stars have a greater velocity. But these are only speculations. For the stars do not fly in straight lines, as this theory supposes, but in a circle. The Creator gave them these circular orbits, that they might go on forever round and round in their orbits, or paths, He laid out for them. If He did not give them circular movement to do this,

they would clash together, or fly away to be lost in vast distant spaces.

But, you ask, did the universe always exist? Is it not infinite in duration? Has it infinite time? If you write the figure 1, and put after it the cipher 0, and so many 0's that the figures will cover the entire surface of the earth, you will not measure infinite time. If you continue till you cover with figures the surfaces of all the planets, the sun, and the whole surfaces of the stars, you will not have begun to measure infinite time, in which the universe would have to be in order to be infinite in time or duration.

Stars are always sending out light and heat. Their light and heat cannot last forever. For a time must come when all their light and heat will end, unless, kept up by a Power not in themselves. Every source of light and heat must be fed, or it will go out. The stars we see still shine or we could not see them. If they had been from eternity, they would ages ago have lost their light and heat, for in giving these out they are cooling.

The general impression is they are fed by meteorites and great bodies falling into them. But if these bodies were infinite in number, which would be required to keep up the starlight and heat forever, they would fill all space solid, so there would be no vacant places between the stars. All would be one tremendous body of solid matter extending beyond the confines of the Milky Way. The universe cannot therefore be infinite in duration in the past. A time was when matter was not. We find it here, and therefore at some remote time it was made.

Lord Kelvin, the greatest scientist of our day, who devoted almost his whole life to these questions, figured a star moving in a circle within a diameter of 3,215 light years in which would be distributed 1,000 million suns each with the same amount of matter as our sun, all suddenly created and subject to gravity or weight alone. He says they would all at once begin to move slowly, especially those near the center. But after 25

millions of years, many of them would have a velocity of from 20 to 70 miles a second. These diverse velocities agree with that of our stars, and from these figures Lord Kelvin thinks there may be as many as 1,000 million suns in the universe. Then he went over the figures again, supposing there were 10,000 million suns in the universe, each having about the same amount of matter as our sun, and found the velocities within that time would be much greater, and concludes that there are not that many suns, nor that amount of matter, in the universe. We see, therefore, from the learned studies of this great man, that the universe is not infinite in extent, nor space boundless, nor that matter was not from eternity. These figures, with the calculations of other learned men, prove that a time was when matter was not, and that it was created.

Professor Newcomb supposed 100 million suns, each five times as large as our sun, the whole amount of matter being equal to 500 million suns, equally distributed through an extent of space 30,000 light years across, acting under the laws of gravity alone, and he reaches the same conclusions. Other men went over these figures, followed up the movements of every star, sun and planet known, imagined the materials of the stars into different kinds, and sized orbs at different distances from each other. They weighed these bodies and measured their supposed motions. Many mathematicians went over this work. Lord Kelvin at another time divided all the materials of the universe into 1,000 millions of suns, each 300 millions of millions of miles apart, and figured out their movements.

These men were forced by their mathematical calculations of the motions of the stars to conclude that they are not eternal, and that a time was when there was no matter. The universal movements of the stars prove the universe is not eternal. For these mathematical reasonings, the purest truths of human reason, absolutely prove by these investigations that the stars were

not always, that they were made, that they have a Creator.

These men did not start out to prove the existence of God, but to investigate the secrets of nature, searching out the laws, movements, masses, weights and natures of the stars. They were forced to the conclusion that the heavenly orbs as they now exist could not have been from eternity, that in the far-distant past these movements began, this weight, light, heat and electricity had a beginning, and a time will come when they will end. Thus the truth of creation, a beginning of things, were forced on their minds by their investigations.

Every star you see throws out light. This light is caused by the matter of the great fiery globe condensing, or it is sustained by meteorites and other bodies falling into the fiery mass. If these suns had existed from eternity they would have cooled long ago, or new matter would have to be created to sustain their light and heat. Whatever way you look at it, you find the marks of the Creator. There is no other way of explaining the wonders of the universe, except to say God made matter. A hundred reasons might be given to show that the material universe is not eternal. It must have been therefore made at some time in the remote past. In this science agrees with these words, majestic in grandeur, "In the beginning God created heaven and earth." Gen. i. 1.

If stars could be seen only from one place on earth, a learned man said, great pilgrimages would be made to this place to see the wonders of the heavens. But they surround us on all sides, we can see them any clear night, so the sight has become too common for us. We do not value what we meet every day and therefore we forget the wonders of the heavens. Even if we turn our eyes to the stars few of us know their wonders, and soon we return to earth and forget our Creator amid the busy scenes of life.

CHAPTER II.—THE NUMBER OF SUNS AND THE DISTANCES SEPARATING THEM.

Five hundred millions of suns. Thousands and thousands of nebulæ condensing into suns. Spaces so far, so wide, so deep, that light traveling at the rate of 186,000 miles a second takes 1,800 years to reach us, and 3,600 years to cross the universe. Gentle reader, can you grasp these figures? Do you realize the amount of matter God made, and the extent of the heavenly spaces? When we say God is infinite in might, do we understand His power? We have no language, no words, no ideas to express what it is to be infinite, boundless, eternal, almighty. God found no more difficulty in making these orbs of heaven from nothing than if He had made a tiny grain of sand to float in space like little grains we see falling as shooting stars in clear nights.

Why did He make so many orbs? Are not so many utterly useless? Man as a reasonable being, using his reason, never works without a purpose an object or an end. In making these millions of suns God had a purpose, an object, and an end. For as the highest reasoning Being, He could not work without a motive, an object and a purpose. If He made them to serve no useful end, He would have worked as an unreasonable Being. That God could not do without abusing His reason, being the infinitely perfect Reason, He had a motive in making them. Why did He create so many suns in such a variety of size, light, heat, colors, and at such enormous distances from each other?

The space between the stars is cold, a cold near absolute zero; that is — 449 F. If the cold of the spaces

between the stars were that of absolute zero, this cold would penetrate the atmosphere, except during direct sunshine, so that at night man, plants and animals would freeze to death. Ice would cover every body of water, and life would soon cease. These millions of suns throw out their heat on all sides, and this gentle warmth is greater within the center of the great wheel of the Milky Way, where we are. This heat pervades all matter, enters our atmosphere, strikes down through the ground, preventing it freezing deep into the crust of the earth. This heat is radiated through the whole bulk of the earth's mass. You will find no part of the earth deep below the surface frozen, as it would be without the heat of these millions of suns. As you go deeper into the earth you find the rocks get warmer, till, if you continue, you will come to very hot rocks about 10,000 feet deep, and if you could dig deeper you would at last arrive where all is melted with the interior fires of our planet.

The heat from the melted interior of our earth, and the heat of the millions of suns meet and pervade the ground, keeping it from freezing, aiding life functions of plant, animal and man. If suddenly these vast suns were blotted from the firmament, life would cease from earth. This is the reason God made so many millions of heavenly orbs—lest we might perish from the earth with all that live.

Beginning with 1900, Mr. Nichols, during two years at the Yerks Observatory, carried out a series of experiments, with instruments of special construction, to measure the amount of heat we receive from the stars. We will not fill our pages with the details. Vega gives a heat of about one two-hundred millionth of a candle at 39 inches. Arcturus gives 2.2 times as much. In 1895–96, Mr. Minchin and Professor Fitzgerald, of Trinity College, Dublin, measured the heat of many stars, the light of most being strong enough to print a photograph on sensitive films. But these suns, millions in number, are pouring their heat down on us not for

hours or days, but since the beginning of creation. They have been sending out to earth not only heat, but light in all the colors of the rainbow, Roentgen rays, Hertzian rays, and Ultra rays, etc. We can hardly imagine what an influence they exert on the world, and on the living beings which sport on its surface. These rays penetrate the hardest rocks, and enter the tissues of all living beings. What an interesting study it will one day be to examine the influences of these light and heat rays from the stars falling on earth!

A man's body, trunk, leaves and limbs of trees present large surfaces to these star radiations. Many life functions we do not now understand are caused by these forms of energy coming from the fixed stars. This subject has not been studied out. The light of even the smallest stars causes chemical changes. Plants, animals and the human body grow mostly at night, and this takes place entirely or is helped by the light and heat of the stars. What a Providence presided over the creation of matter in the formation of these millions of suns! What wonders we see in the light, heat and electricity streaming out from these twinkling stars down on us and on our earth, within the mighty Galaxy wheel. We get only a glimpse of the wonders of these forces, and the farther our knowledge penetrates the mysteries of nature, the more will we be raised up to the knowledge of the great Creator, who made all these for man's use and benefit.

Now let us see how far these millions of suns are from us. Then we will get a more or less confused idea of the tremendous extent of the spaces between the stars. The reader is asked to think well on these numbers given as so many million miles.

How oft we talk of millions, but do we understand what a million is? As here we have to deal not only with one, but with hundreds and thousands and millions of millions, we will try to explain the meaning of a million. Take 100 sheets of paper each 4 1-2 feet square, rule each into quarter-inch squares and put in each

square a little round black dot or paper. Each sheet holds ten thousand spots, and one hundred such sheets would hold a million spots. They would stretch out 450 feet in one strip, or 90 feet in five rows, and would cover the walls of a room 30 feet square and 25 feet high. Build 93 such rooms, cover the four walls 30 feet wide and 25 feet high with paper so prepared, each square representing a mile, and you will have an idea of the distance to the sun. But multiply 1,000,000 by 1,000,000 and the result by 12,600, and you will have the distance to the nearest part of the Milky Way. The human mind even can hardly grasp the tremendous distances of the spaces between the stars.

Before mankind learned the true framework on which the universe was built, people thought the stars were points of light attached to crystal spheres which carried them round our earth each day. But when Copernicus gave forth the real arrangement of the heavenly bodies, that the earth and planets revolve round the sun at a distance of many millions of miles, the old astronomy of crystal spheres was abandoned and the new science of the stars began its conquest of the heavenly bodies.

The telescopic discoveries of Galileo, Kepler's laws, Tycho Brahe's researches and Newton's universal gravitation and the investigations of the men who came after them opened up a wonderful field in the heavens. Wealthy men and governments established observatories served by men devoted to the study of the stars.

If, they said, the earth swings round the sun once a year, carrying with it the moon, its satellite, why do the stars not shift their apparent positions when seen from the other side of the earth's enormous orbit? Copernicus, Galileo and Kepler said it was because they were at such enormous distances from us that the path of the earth going round the sun was but a point compared to star distances. But human minds could not then grasp the real idea of such enormous distances, the world refused to believe, new ideas are always opposed, and

long and warm were the disputes among the learned. It had come down from time immemorial that all was made for man, that the earth was the center of the whole universe. But these new theories removed the earth from its central position in the heavens, and many supposed the teachings contradicted revelation. Books were written for and against the new astronomy, and disputes disturbed the world in the days of Galileo.

Slowly but surely Father Copernicus' discoveries made their way among the learned, who began to investigate the heavenly mysteries. Towards the end of the eighteenth century Venus passed between us and the sun, her transit was then carefully measured and later with transits and more refined instruments. When the observations were figured out, they gave the sun's distance as 92,780,000 miles. Here was a base or a giant yardstick with which to measure the distance of the stars.

Six months later the earth is on the other side of the sun, 185,800,000 miles from where it was, and this is the enormous base-line we use in our measurements. We can measure the width of a river or any distant object by marking off a base-line the length of which is well known, and then taking the angles as we look at the object we wish to measure, we can find the distance within the fraction of an inch without crossing the river. A little figuring and measuring of base-line and angles only are required.

Learned men applied these principles to the stars to find how far away they were, about 40 stars have been measured and about 30 more with not such exact results.

Riding on an engine, or on the front seat of a trolley car, distant objects open out as you come nearer, fly past and group together behind. Do the stars show our sun with his planets traveling through space? Sir William Herschel a century ago suspected that they do, and set to work to find where we are going. From the motions of the stars he judged we are traveling towards

the constellation Hercules. Later learned men took up the question, found he was right, and fixed the star Arcturus round which, with our sun, we are sweeping in a mighty orbit we will later describe.

How was this found? Long, numerous, and careful observations showed that towards Hercules the stars are opening out, separating from each other and that on the opposite side they are closing up, as you see objects when you ride in a car. Carefully measuring these motions, the place towards which the sun is going was found. After a study of many thousands of star-motions, was the point determined towards which we are traveling, with our sun and his planets at the rate of about 12 to 15 miles a second, 189,216,000 miles a year.

The changes of place of the stars led to remarkable conclusions regarding the vast expanse of the universe. The mind cannot grasp the distances between the stars. The changes of about 50 stars, called their parallaxes, have been so often measured they are looked on as correct. They vary from three-quarters to one hundredth of a second. Using our base-line of 185,800,000 miles, the diameter of the path or circle the earth follows round the sun each year, and using the finest instruments, after thousands of observations we can find no change in the positions of the stars Rigel, Canopus, and Alpha Cygni. How far, then, are they from us? We cannot express it in figures, for numbers would be meaningless. We must depend on their brilliancy, and on the spectroscope to tell their distance.

Six other stars. all but one of the first magnitude, have a parallax of 1-50th of a second. Nine more have a parallax very small or none at all, six of them are in, or very near, the Milky Way, which is so far away that all studies up to our day show no parallax for any of its stars. As nearly all the stars are distributed within or along the borders of the Milky Way, we can conclude at what an enormous distance most of these stars are. We

can only express their distances by the time it takes their light to come to us—that is, from 400, to 1,800 years traveling at the rate of 186,000 miles in a second Reader, looking into the depths of these spaces in which God made matter, can you grasp the extent of the spaces between the stars? Multiply a million by a million, this by twenty-six, and the result by a hundred and you have the distance to these stars expressed in miles—that is, 2,600,000,000,000,000. All sources of error were studied and taken into account, and the distances, enormous as they are, were found about as given.

Then they used another method to see if these figures were correct. Oft two stars near together appear in the field of the telescope, one having no motion, the other found to be moving. In 130 before Christ, Hipparchus gave the position of many stars, and in 1717 Halley found many of them did not occupy the places this Greek gave them. Later observations showed that numerous stars are changing place, and after 40 or 50 years their motion can be measured. Some move at the rate of from 7 to 8 seconds of a degree in a year, while others require 20, 40 and 100 years to move that much. Not the brightest but often stars of lowest magnitude show the largest motion—in fact, some of the brightest stars have no movement at all. This proves the stars are not all of the same size. One star of the sixth magnitude has the greatest movement.

A hundred stars have been found having each year a movement of more than one second of an arc; a large number have less than this, but the large majority are immovable as far as can be seen. The easiest way is to compare a moving star with one that has no motion; observe them every fine night as they come into the telescopic field, and mark their places. In this way more than a hundred measurements can be taken in a year. How is it done? With the Heliometer, a telescope with the great glass in its upper end cut in two through its center, the two halves slide one on the other by a very

fine screw motion marked with great care. Turning this screw brings the two stars one upon the other to see if they moved since the first time they were seen. Each half of the glass of the great telescope brings one of the stars to the eye and no corrections are wanted. Many men in different parts of the world look at the same stars at the same time with this instrument, their figures are compared and found to agree in a striking manner.

Professor Pritchard of the Oxford University first used this instrument with a reflector of 13 inches. Later, other astronomers photographed the stars with it, thus fixing their positions on the silver print so they can be studied at leisure. Before they published the distance of 61 Cygni, they took 330 different photographs and took 30,000 measurements of other stars shown on the pictures, and compared them with the measurements given by the method used before. We give these details to show with what care astronomers carry out their work before giving the results to the world. No guessing is ever allowed in science where we are looking into the work of the Almighty's figuring, who made the universe and based it on mathematics.

Weak is the will, darkened is the mind steeped in worldly things, we do not see the Might of God and seldom think of Him. We are gazing out through our instruments on the footprints of His infinite power.

You who under starry skies can never pray,
Scoff not at me a thinking clod;
For me my strength from day to day
Is in Communion with my God.

Ever round me life throbs, and I stand
Outgazing on His tremendous Power
Who lives within me and on either hand.
Him I adore each fleeting hour.

From farthest historic times, men believed earth the center of the universe, till in 1542, Very Rev. Father Copernicus, canon of the cathedral, published his book with his theory that the earth was only one of the small

heavenly bodies revolving round the sun. But old ideas die hard, and a storm rose round his head. Tycho Brahe rejected his theory, and spent 20 years measuring with his most accurate instruments the changes of the stars from their positions as the earth swung round the sun, on her path 185,800,000 miles in diameter, and he failed to find the slightest movement in them. But Tycho, with his finest instruments, could measure only four minutes of an arc. Still Copernicus' system made rapid strides among the learned.

In 1610 Galileo pointed his little telescope to the fixed stars, other astronomers took up the work, but for 108 years no star was found to change its position. The micrometer was invented, the two Herschels and Struves worked on the problem of finding the distance of a star, two centuries of vast labor passed, and in 1840 Bessel, after working three years on the problem, found the distance of 61 Cygni by triangulation. This star is 590,000 times farther from us than the sun. Multiply this by 93 millions of miles, and you have the distance of this star, from which it takes light with the velocity of 186,000 miles a second, 9 years to come to us. The distance is so great it is unthinkable.

At the same time Henderson, at the Cape of Good Hope, with more perfect instruments, was taking observations of the star Alpha Centauri, and found it 275,020 times farther away than the sun. Other noted men took up the work, and measured the distances of many stars. Light takes about 4 years and three months to come to us from the nearest fixed star. The distance of about 50 stars has been measured, but the most delicate instruments man will ever make will not measure how far away are hundreds of millions of suns.

The nearest star is over twenty-five thousand billion miles away. This distance is beyond the grasp of the imagination, though not beyond the reach of mind guided by mathematical calculations. A spider web is so fine that a pound of it would encircle the earth. It

would take ten pounds of it to reach the moon and over three thousand pounds to stretch to the sun. But enough to reach the nearest star would weigh half a million tons. If a railroad could be built to this star and the fare fixed at 2 cents a mile, the ticket would cost $125,000,000,000—thirty times more than all the gold in the world.

The north star is about two hundred and fifty billion miles distant, its light takes 45 years to reach us. We see the fixed stars with the light which left them on its flight years ago. If every star were blotted out, four and a half years would pass before we would be aware of the fact regarding the nearest, and hundreds of years before the light of the most distant would be extinguished for us.

Alpha Centauri and 61 Cygni are the nearest stars. The first is in the constellation Centaur, and the latter in the Swan. The first, brightest star in the southern heavens, is 275 times farther than our sun, that is 25,547,500,000 miles away, its light taking four years and three months in its flight of 286,000 miles a second to come to us. The light with which you see it was that time on its journey. The star 6 Cygni is nearly twice as far away, and its light is seven years and three months on its flight before entering your eye. We must remember that the brightness of a star gives no proof of its distance, as they are not of the same size.

Sirius, " The Dog Star," brightest in the northern sky, is fifty-eight thousand billions of miles away (58,000,000,000,000). The Polar star is two hundred and ten thousand billions of miles from us (210,000,000,000,000). This is the most important star in the heavens, because being almost exactly north towards which the north pole points, when seamen see it they know how to stear their ship. It is 2,152,841 times the distance from here to the sun. If we could run an express train at 60 miles an hour to the Pole-star without stopping it would take 350,000,000 years to reach it.

Sirius is 7,000,000 miles in diameter and has a mass 7,000 times greater than the sun. The size and weight of Sirius seems great compared to our sun, yet it is quite small when compared to the mighty Arcturus, round which we are going with the sun at the rate of about 150,000,000 miles a year, as some astronomers estimate.

These distances are overpowering to the mind. We cannot grasp them. The distances between things on our little earth give us no idea of how far from each other the stars are separated. We can only take the distance from here to our sun as a yard-measure, and that gives us but a vague conception of the grandeur of the plan on which the Infinite built His universe. The question rises in the reader's mind: Why are they so far away from each other? There is harmony and design in nature. All matter attracts all other matter by weight.

Suppose the suns, now so far separated, were grouped close together near our solar system, three effects would be produced. The light and heat of so many suns would be so overpowering that nothing could live on earth. The whole world would be melted with their terrific heat. The sky would be like a furnace blast of melted iron. Sun and moon produce the tides, and these mighty suns would cause tides in the air, producing vast destructive cyclones. The tides in the sea would sweep over the continents, destroying all life. The attractions of these tremendous suns so near us would pull the earth out of its course, near the sun sometimes and away from him at other times, so the changes in his light and heat would be so great that nothing could live on our planet. But the stars have been placed by a far-seeing Providence so far away that these changes do not take place.

For centuries learned men, versed in all the sciences, devoted their lives to the investigations of the vast problem of the universe. The laws of attraction, the weight of all the suns, their motion, centripetal and centrifugal forces are well known, and the amount of matter God

made diffused in the shape of globes have been figured out. All the suns are in motion. If one was at rest it would fall into another. If one is coming towards the earth or going away, the spectroscope reveals it, and tells us its velocity. Careful calculations of star No. 1830 of Groombridge's catalogue have been made, and its distance found to be 2,062,650 times greater than that of the sun from the earth—that is, 192 trillions of miles. Its revolution takes place in 195,000 years, its motion through space being 200 miles a second. These figures are overwhelming—even to trained minds of astronomers used to computing vast figures. By a long series of figures we find this star has 300 million times more matter than our sun, which has 333,000 times more matter than our earth.

You can therefore imagine how much material this star contains compared to our earth. But this is only one star out of millions, and you can therefore have a faint idea of the whole matter brought forth from nothing at creation. They estimate the amount of matter required in the universe, the weight of which gives this velocity to this star, must be at least 32 billion times that contained in the sun. But as the visible stars contain much less matter than this, it is estimated that there are millions of dark suns or globes floating in space.

When, the distances of the many stars having been measured, we compare their light with that of our sun, examine them through the spectroscope and learn many things relating to these brilliant bodies. The star Rigel gives about 10,000 times as much light as the sun, so that if its surface has the same brightness, it must be 100 times larger than the sun. But as our sun belongs to the yellow species of suns, for its light is not white but yellow, Rigel, Sirius and such white suns must be from 1,000 to 2,000 times larger than the sun, 853,000 miles in diameter; Rigel must be at least about 85,300,000 miles in diameter and would almost fill the space between us and the sun.

B Aurigæ, a white star of the second magnitude, is a double star, and Mr. Gore figures that its materials are five times the mass of the sun. G. Leonis, 300 times more brilliant than our sun, is composed of glowing gases seven times rarer than air; a surface needed to give the same amount of light is thousands of times larger than the surface of the sun. Examining one after the other of the stars whose distance is known, we find many of them much larger than the sun.

Many stars found nearer than the ones given above, are only one-fiftieth as bright as the sun, therefore, they must be either smaller, cooler, or give out less light. If the nearest star, A Centauri, had a diameter as large as the distance from us to the sun, it would be seen with a disk as large as that of Jupiter's first satellite.

How little we think of the distances between the stars. Suppose we start on a journey to see some of them. We will take a beam of light as our railroad, and go with the rapidity of light. The first second we passed along 186,000 miles. The next second we are 372,000 miles away, and in three seconds we are 558,000 miles on our journey. In ten minutes we are 112,600,000 miles from our earth. An hour goes by, a day, a month, and years pass, as we continue without stopping our flight of tremendous swiftness, and then we are only approaching the nearest star. Centuries roll by and after 1,800 years we at last arrive at the outer boundaries of the Milky Way, where we look beyond into dark nothingness—eternal night. There we are at the limit of that space, in which the Almighty made the stars and suns and nebulæ to float and circle round.

But let us give a more detailed description of what we saw on our flight through space. When we have passed twenty-six hundred of millions of miles we are approaching the nearest of the stars. We take our stand on one of its planets, and wait to mark the altered aspect of the heavens. We see the old heavens have passed away over our heads, as well as old earth from beneath our feet.

But not entirely, only the nearest stars have changed their positions. There is the Little Bear with its Polar star and the Great Bear with its Pointers. There the bands of Orion, and the Pleiades still hang in the same place. Vast as is the space we passed, it is not a thousandth of that which separates our earth from the most distant stars. The mighty Arcturus is still as it appeared to Job so long ago, and Mazzaroth as seen from earth. They all appear as would the trees and objects in the landscape if we had changed our position on earth about 60 feet.

Let us go on. Sun after sun beams upon us, each with his brilliant band of planets and comets; sun after sun sweeps by, the light from them paling in the distance, as we leave them behind in our flight, and a change creeps over the face of the heavens. The general outlines and figures of the constellations remain the same, but those behind gradually group together and shrink, while those in front open out and grow larger. As we near the Milky Way, the stars become more numerous. They seem in some places bunched together while long wide and deep rifts are seen between their constellations.

We pass through this mighty Ring of stars with which God encircled his material creation, and look into the mysteries of vasty abyss on abyss beyond. Nothingness and dark eternal Night reigns beyond the outer stars. Before, behind, to right and left—whichever way we turn our gaze, it meets with naught but the utter blackness of darkness—the deep gloom of the starless midnight sky is unbroken by the gleam of a single star. Onward still we wing our daring flight, the last resting-place of matter is passed, the last star oasis is left behind, as we shoot into the trackless wastes of boundless unmeasured space. Long ago the earth dimmed and went out. Long since our sun disappeared. The constellations grouped together and became bright clouds of light. And now we see far behind a great ring of stars, far away it is getting smaller and smaller all the time, till at last this too has quenched

its light in the deep gloom. All created matter has been left behind, and we stand alone face to face with that eternal nothingness, that darkness on the face of the abyss in which God made matter when he created heaven and earth.

But suppose we brought our greatest telescope with us, now we turn it on the universe back of us and take a look at the worlds we left behind. From the darkness steals out a white patch in the centre of our field of vision. We turn on the higher powers of the glass, and the sky is mottled with little flecks of white. We move the great glass a little and new spots of white are seen. As we swing round the telescope on all sides, the stars are seen as motes that dance in the sunbeams on a summer day, but they are close as are the stars in the firmament they are as numberless as the grains of sand on seashores. They are the constellations within the tremendous ring of God's worlds, they are the rifts and clusters of the Milky Way, now looking like clouds piled up as on a summer day.

Back towards created worlds we go seeking out these bright clouds in our flight for home. The white patches and clouds get larger and larger. The great ring opens out. A thousand, and more thousands of suns dissolve from the clouds and brighten into orbs, some white, some red, others yellow. They are of all colors of the rainbow. They are God's precious stones, but glowing with their own light. The diamond brilliant blue, the amethyst glow, the topaz, the green of the emerald, the ruby's gleam, the tourmaline's sparkle, all precious stones we prize on earth—all are but weak imperfect images of these glowing suns. Not one of these suns is less in wonder, in glory, in beam and splendor than our sun. How little we think of God who shows his wondrous power and glory in the worlds of matter he brought forth from nothing.

Let us force in on our mind the awful extent, the inconceivable grandeur, the mighty plan, the tremendous

foundations on which Omnipotent built the universe. Our earth goes round the sun once a year, and in six months we are 186 millions of miles away from where we were. We take an observation of a star at both places, but the very finest instruments give only a change of one-tenth of an inch, seen at a distance of 1,730 ft. Alpha Centauri, the nearest of the stars to us, shows a change of only $\frac{3}{4}$ of a second, that is double the distance of the earth from the sun, a space 185,800,000 miles, seen from that star, would appear no larger than a tenth of an inch, seen a third of a mile away. The reader will, therefore, realize with what care astronomical instruments must be made and what problems learned men must work out before they lay their discoveries before the world.

Faint feels the human mind before these distances, and we ask ourselves where are these magnificent creations rising above each other in the scale of grandeur and magnificence to end. First we have our little earth, with its varied living beings of plants, animals, and men, the other planets with their attendant moons and satellites swinging round the sun, then millions of other suns each with his suns or planets circling round him, then thousands of great clusters of suns, sometimes millions in each, and at last comes the mighty Milky Way, running round the heavens, inclosing as with a nuptial ring all matter made by God. How far must we go, how many years will pass, how many learned men will have to devote their lives before we will know all the mysteries of these worlds, and suns and planets? Our finite powers perhaps will never sound the depths of material creation. A veil never to be pierced will always cover the details of the heavens. The Almighty has placed his stern fiat before the advancing flood of human knowledge, which fain would penetrate the mysteries that are beyond. We are in worlds of dead, crude matter, with only force and movement developed into light, heat, electricity, attraction

and repulsion. But while glory rises above glory in the starry heavens, there is another wonder—life, lowest in the plants, higher in the animal, transcendent in man's reason, higher still in angel, but eternal life in the Godhead. There, not in place, but in nearness to the uncreated Godhead, who shines not with reflected light but with the light of glory, there is the source, the eternal Reason, the Mathematician, who built the universe according to the plans and specifications infinite and eternal in Himself.

O night how sublime is thy language for me
When calmly and thoughtful I look up to thee
Five millions of suns roll there in thy breast,
There from creation thy vasty form dressed.
Telling us of the powers of Him we adore,
Till we long to go live with him evermore.

CHAPTER III.—SINGLE, DOUBLE, CLOUSTERED, CHANGING AND COLORED SUNS.

A STAR to naked eye seems a point of light, through the telescope it is the same point and the highest powers of our instruments never show a disk. Long the fixed stars were supposed to be single bodies, but the spectroscope and other instruments prove them double, triple—that is two, three, four, or more suns revolving round their common center.

During the first half of the nineteenth century, many thousands of such multiple stars were discovered, and as the powers of our instruments increased, different observatories found them in thousands. Professor Burnham of the Yerks Observatory reported having discovered 1,290 such stars between 1871 and 1899, these having been found by the great telescope alone. But when the improved spectroscope was turned on the sky, it opened up a world of new wonders. Double, triple and multiple stars of enormous extent and numbers excited the highest curiosity and interest.

The orbits or paths they follow going round each other were figured out, it was found their revolutions range from periods of 11 years, the shortest observed by the telescope, up even to the millions of years it takes the widely separated stars of the constellations to make their revolutions. But the spectroscope showed them moving in revolutions from thousands of years down in unbroken series to a few years, to months, to days, even to hours. The time of their revolutions enable us to figure out their distances from each other, the weight of matter in each sun, the amount of light and the heat they give. We can tell the size of these bodies. For as all matter is ruled by mathematics even to the farthest

ends of the universe, we follow the footsteps of the Creator who made them, weighed them, put them at that distance apart, and gave them the impulse by which they circle round forever.

We find some suns separated from each other millions of miles, others are nearer and nearer to each other, some go moving slower, others faster according to the mass of materials and distance they are apart. But some are found actually in contact, that is, one sun is breaking away from another. Thus we can look at suns and worlds being born as our earth was formed from our sun in these far-off days, when our planetary system was constructed. In 1892 Professor Lee of Chicago foretold this mode of the division of suns, and in ten years his words were fulfilled, for suns were observed in process of formation.

As these orbs of gases or suns, turn faster and faster on their axes, great tides are produced in their equatorial regions, and as the rotation becomes quicker, a ring of glowing matter breaks off, as a wheel bursts, and this matter forms a new sun whirling round its primary. According to the natural law this new sun should rotate farther and farther away, and at last go wandering through space as an erratic body. But it does not. When it gets so far away that its tendency to fly away just balances the attraction of the two bodies, an Almighty Power steps in, stops it from going farther and there it goes on forever.

In 1902 Professor Campbell published his researches at the Lick Observatory, Cal., and states that out of 350 stars he examined, one in eight was found to be double, and he concludes with these words, " The star that is not a spectroscopic binary will prove to be a rare exception," Professor Darwin shows that the " dumb-bell " is a figure of equilibrium. We find it exists in the stars, and that it was the starting point in the formation of the ever-increasing number of double stars we are finding almost every day. Learned men have figured out that when our

earth was being formed, it broke up into the "dumb-bell" form. That is, following the laws we see ruling the double stars in their formation, a great mass of matter was jerked out of what is now the great depression of the Pacific Ocean. This great mass of materials became the moon. As the earth rotated round on its axis faster and faster as it condensed, it thus threw off the moon. But our satellite did not go wandering through space, for God placed it where it is now. "A lesser light to rule the night, and the stars." Gen. i. 16.

Most people believe the stars are round as a ball. The greater number are round, but many are shaped like an egg, a long cigar, or a lens. The attraction of other stars and their rapid revolutions pull them into these shapes. As they become more elongated the excrescence is thrown off, and becomes a new star. In this way the double, triple, and multiple stars were made. This was the way the planets were thrown from the great nebula, or gaseous misty globe of matters, now composing our solar system. But when these orbs are thus thrown out from the central body, they do not go wandering through space to collide, perhaps, with other suns, bringing destruction and disorder in the heavens. The Almighty steps in and fixes them in their orbits.

Beta Lyræ is the brightest of the pear-shaped stars, and in time it will divide into two suns. This is the way the double stars were made. Algol, most mysterious of the changing stars, is pear-shaped, and when it turns its larger surface towards us it appears much brighter than when it turns its smaller surface. Ten pear-shaped stars have been found, five in the northern and five in the southern hemisphere. Two of these are of special interest. For the bodies composing these two stars are in actual contact like a figure 8. When they get a little farther apart they will be like dumb-bells. Later the connecting link will snap and they will revolve farther and farther from each other, their surfaces oscillating in great swelling pulsations, gradually dying down

like waves. Thus suns and worlds are born in the heavens.

The nearer these bodies are to each other the more oval-shaped the orbs are, because of the mutual attraction, and they are slowly receding from each other. We have an example of the oval form in a small way, in the tides, caused by the attraction of the sun and moon, which raise the waters of the oceans. As all stars are metallic gas and vapors in an intense condition of heat, they are pulled out of the round shape when near another great body. The raising of these mighty melted metallic tides on stars, uses up the energy of gravity or weight, and shoves the stars farther apart in an ever-widening spiral. Then one after another these suns become pear-shaped and take on other shapes at different times. They shed great portions, which become planets. But the breaking up of matter into worlds does not continue forever, or the universe would be separated up into little grains of matter as at creation. For a third law steps in to stop the process of breaking up. The gaseous globe condenses by loss of heat so that farther divisions are impossible.

The movements of these millions of suns prove a Providence presided over their creation. Their motions subject to law, guided by mathematics, show an Intelligence, infinite in wisdom, directed them, and still presides over their gyrations. The mechanics of the heavens prove God. Reason draws no other conclusion.

O see how the stars in their courses are swinging,
Each steadfastly held in the grip of the law,
Like silent light choirs they ever are singing
Silent hymns to the Eternal we never saw.
Look and see how the orbs shine in the offing,
Since creation floating on highways they trod,
O how my heart sinks when I hear people skoffing,
Who never have studied the wonders of God.

The brightness and density of stars depend on: 1, their distance from us; 2, their diameter, and 3, their

brilliancy. We measured the distance of many stars, we found their diameters by the times of their revolution, whether they are double, or when three or more revolve round their common center of gravity, and the spectroscope shows the materials of which they are composed, as well as their brilliancy.

Orion is the brightest star in the sky, and Sirius comes next. Regel is 7,800 times brighter than our sun would be if removed to its place. It has a small companion of the 8th magnitude, which itself is double. Regel's mass has not been exactly figured out, but it must be enormous to shine with that white light which takes 300 years to reach us. Professor Gore estimates Regel as 20,000 times larger than our sun. He says Sirius is 31.6 times brighter than our sun would be in the same place. Dr. See says Sirius' mass is 2.36 times that of the sun, and it is 18 times brighter. The spectroscope shows it much hotter than the sun, while its materials are so scattered with the awful heat that they resemble the nebulæ. We know from these observations that his mighty mass extends for millions of miles like metallic vapors, its density being only 0.019 that of water.

According to their brightness, the stars are catalogued. From the first to the seventeenth magnitude, with naked eye we can see only those from the first down to the sixth magnitude. The telescope shows us stars down to the seventeenth magnitude, while the photograph reveals millions beyond the grasp of our greatest glasses.

There are about three times as many stars of one magnitude than in the next magnitude of greater brightness. There are 18 stars of the first magnitude, 55 of the second, 170 of the third, 500 of the fourth, 1,500 of the fifth, and 4,500 of the sixth, beyond which, unaided sight cannot see a star. Bring the telescope to your aid, and millions flash into your field of vision. There are 9,656,000 of the twelfth magnitude, 14,000,000 of the thirteenth magnitude, and they rapidly increase to the seventeenth magnitude, beyond which a 40-inch telescope

cannot resolve them. Now turn the photographic apparatus to the sky, and millions of stars unseen in the greatest glass will print white dots. Men have tried to count them, all agree they number more than 500 millions, while some scientists estimate that more than 1,000 millions of suns shine in the sky.

Who can conceive that number? Who can estimate the amount of matter in the universe? Our finest instruments have penetrated beyond the borders of material creation; pure science, discoveries to our day, higher mathematics, the genius of our astronomers, have sounded the depths of space, forced from nature these lessons of the creative might in the beginning, and prove the indescribable power and providence of Him who made these globes without an effort. Faint feel faculties of man thinking of things cold science tells of God.

Every improvement in photographing the stars shows the tendency of the orbs to arrange themselves in large winding, often curiously looped and involved rows. These star-streams are seen especially in the richer parts of the Milky Way, and the better the photos, the more defined is this extraordinary phenomenon. Besides, there are dark lanes in which no stars are seen, and these are associated with the bright streams of brilliant suns. The appearance recalls crooked paths meandering across a sandy waste, where the pebbles are heaped up each side of the path. Who was the Infinite who walked through these vast regions heaping up mighty suns, as your foot lifts the pebbles and sands when you travel along the dry, dusty plain?

These appearances occur too often to suppose they are accidental. It is plain some Cause with infinite might, placed the tremendous suns in these streams, separated by dark spaces devoid of stars. There is a law we do not understand regulating these things. Why are we down almost in the very middle of the whole universe of suns and heavenly bodies, where all is quiet and stable? Here we are free from the vast forces which

would destroy life. Did no infinite Wisdom place our solar system here where life might flourish?

The suns, both of the Milky Way, and those composing the crystal globes of suns concentric and one within the others, with our sun near the center, must have been arranged with a view of this world with its living organisms. Each star occupies the place ordained for it in the constitution of the stellar universe. The stars have not fallen into the places where we find them by any accident. For the universe is like an immense crystal globe, formed of stars, suns, millions in number, all held by and obeying the laws of gravitation.

Although our sun with his planets seem to us to be separated from the other suns, yet it falls into its place in this tremendous system, and it also obeys the laws which rule the other orbs. Even we are subject to gravitation, for our bodies are heavy, and are attracted by every other sun even if they are millions in number. For all matter in the universe attracts all other matter.

Recent investigations show our sun also belongs to a star-stream, is a member of a star-cluster, and if we could look at it from a sufficient distance, we would find at a glance the suns of the stream to which it belongs. But we think of a crystal ball as formed of hard, rigid, bright material, whereas we know the stars are all in swift motion, all acting on each other by gravitation. This great star-crystal we call the universe "flows from form to form" "changing yet unchanged" never losing its identity. The imagination can hardly picture the gigantic ever-shifting beauty this kaleidoscopic, cosmic crystal sphere of the universe in all its grandeur, harmony and beauty as it is seen by the Omnipotent, who made it of suns and orbs and sent them going on in their motions to mark out a time next in length to eternity.

Now let us give a rapid glance over these star-clusters spread over the sky. Closely examined they seem to be less regular than they first appeared. They have vacant

spaces in them, rifts of different forms, and far beyond is seen the dark heavens where there are no stars. These features are so like what we find in the larger nebulæ, that we conclude these clusters were formed by the condensation of gigantic nebulæ-metallic vapors, gases, dust, and small solid forms of irregular matter. The conclusion is forced on us, that all the stars are the result of matter condensed into globes, from the materials God made at creation, to which he gave attraction and movement.

While the small clusters of stars are found, for the most part, far from the Milky Way, the larger ones are near its borders. The Magellanic Clouds alone excepted, all the great clusters are near this giant ring, where the forces of attraction were strongest, because of the more abundant matter in the mighty circle of suns. The attraction of these millions of stars long ago gathered up the materials of the nebulæ, while far from it the matter was distributed thinner, and it did not condense. Therefore away from the Milky Way we find the nebulæ most abundant.

Round or globular clusters of stars have the greater number of variable stars—that is, suns with changing heat and light. The Harvard Observatory devoted much time to this subject, and of the 23 clusters surveyed with the spectroscope, in which 19,050 stars were examined, 509 were found to be variable, but they were not found distributed in regular proportions.

We have, therefore, a complete system of the growth of suns and worlds from the enormous scattered masses of gases and separated dust, composed of metals we know as nebulæ, or white nebulous clouds, various stars, double stars, triple and quadruple stars, condensing into red suns, these becoming yellow stars as the heat increases, till they become intensely blue stars. Thus the suns are evolved, as they gather the diffused materials, under the laws of weight or gravitation; they grow larger

and hotter, under the laws given by the Great Architect of the universe.

We must remember the most brilliant of these suns, showing in the spectroscope that they are gases, are not always the hottest, or as hot as the suns less bright. For the law is that a sun may become hotter by contraction through loss of heat. For this contraction through loss of heat, when a brilliant body is completely formed of gases, acts thus according to Newcomb's law.

"When a spherical mass of incandescent gas contracts, through loss of heat by radiation into space, its temperature continually becomes higher as long as the gaseous condition is retained."

During the eons of ages while suns are growing in size and heat by the meteorites and masses of matter falling into them, they blaze out brighter and brighter till all the gases, dust, and materials of the spaces round them are gathered in. After that the loss of light and heat is no longer kept up by fresh matter falling, a slow contraction takes place with an increased heat and light till envelopes of melted metals cover their surfaces. These metals floating on the surface, check the loss of their heat and light while the contraction still going on heats them more and more, whence our sun may be much hotter than the most brilliant of the other stars, although it does not give out as much light or heat. For the metals in a state of gases surrounding its surface, retain much of the light and heat. This we see in the solar spectrum lines, which show how the light was absorbed by the metals on the surface of the sun. This explains how our sun sent out about the same amount of light and heat during the enormous epochs of geological times. These laws were given nature that our earth might not be subjected to great changes of climate, which would destroy all its life.

Professor Geo. Darwin says: "The conception of the growth of planetary bodies by the aggregation of meteorites is a good one, and perhaps more probable than the

hypothesis that the whole solar system was gaseous." Professor Wallace says, "The primitive matter, whatever it was, may have been used up again and again, and if collisions of larger solid globes ever occur—and, it is assumed by most astronomers that they must sometimes occur—then meteoric particles of all sizes would be produced, which might exhibit any complexity of mineral constitution. The material universe has probably been in existence long enough for all the primitive elements to have been again and again combined into the minerals found upon the earth, and many others. It cannot be too often repeated, that no explanation—no theory—can ever take us to the beginning of things, but only one or two steps at a time in the dim past, which may enable us to comprehend, however imperfectly, the process by which the world, or the universe, has been developed out of some earlier and simpler condition."

Suns like our own shine on, giving out the same amount of light and heat for ages, but others change from time to time. These are called the variable stars. The periods of change are of all lengths. The period of the change in 30 Hydra of Havelius is 494 days, during which time it blazes out from the dark sky, till it becomes a star of the fourth magnitude, then it gets dimmer and dimmer, till it utterly fades away into the dark heavens. The star X of the Swan varies from the fifth to the eleventh magnitude in 404 days, O of the Whale, called the Marvelous—Mira Ceti, varies from the second magnitude to total extinction in 334 days. D. of Cepheus in 5 days, 8 hours and 37 minutes, changes from the third to the fifth magnitude. Many other stars change in varied light, and in different times. These changes have excited the curiosity of the learned in all ages.

What are the gigantic forces playing in these suns? Maupertius says they are in the form of a lens. That is, they turn so rapidly on their axes that their equators are thrown out so they form gigantic lenses. When

the face of the star is turned to us we see a great amount of light. But when the edges of the lenses are turned to us the light is not so great. But some suns which shone in former times disappeared long ago from human ken. In 1437 appeared a star in Auriga II of the Wolf, marked in Ptolemy's catalogue but is now no longer visible. In the seventeenth century, Cassini, and in the eighteenth century, W. Herschel pointed out a great number of stars which have completely disappeared. What has become of these suns? What gigantic causes brought about their death? Science has not yet answered. Will our sun and world end this way?

October 10th, 1604, in the constellation Serpentarius, appeared a star Arago described as white, it became the brightest body in the heavens, surpassing Mars, Jupiter and Saturn near it. It rapidly lost its light. Kepler saw it for the last time on November 16th, when he was at Turin, after which it disappeared, but it appeared again at the end of December, when it became brighter and in January surpassed Arcturus. During 1605 it seemed almost as bright as Saturn and then it diminished till in March, 1606, it disappeared forever. This is but one example of some of the wonders seen in the heavens which up to our day have not been explained.

Stars are divided into five classes. Some suddenly appear out of the dark firmament and are called Novæ, "New." Others change their light for several months, and are named "long period" stars. Others have short and irregular changes. More have very short periods of changes. In these changing orbs, Mrs. Fleming says, these hydrogen lines are very bright, and Professor Bailey found all the stars and some clusters to be variable. Half the stars have hydrogen gas at a tremendous heat, these hydrogen stars are thickest along and through the Milky Way. Without this gas, they would be invisible, they are so far away. But the stars we see scattered through the sky and which are nearer to us, show about the same materials as metals we find on earth, and in

the sun. Professor Pickering says the stars are distributed in the heaven, not by chance, but according to a regular law, and that if they were infinite in number and spread through endless space, the whole heavens would be as bright as the face of the sun all the time; the heat would melt everything, and nothing could live. If they were infinite they would touch each other and could not revolve. We see there is a design all through the universe, and who was the Designer but the Eternal?

Many variable stars were discovered by the spectroscope in 1904. Only one star out of 10,000 is visible to the eye. We see with the eye only about 2,000 stars. Red and yellow orbs are brighter than the green or blue stars. Blue stars print better on photo film than the red or yellow suns, and appear larger in the photos. Right ascension corresponds to longitude, declination to latitude on earth. A.D. 150, Ptolemy catalogued 1,030 stars. About fifty years ago, Argelander catalogued in the northern hemisphere 324,000 down to 9th magnitude. Work of cataloguing the northern hemisphere is going on, estimated down to 10th magnitude, 1,150,000.

The Nebular hypothesis, first broached by a German, Kant, was taken up by Laplace, a French mathematician. When a star ring breaks up the materials must fall into some central mass. "To form planets, an external force must come in," says Professor Darwin. "Who was this but God? This theory without an act of the Deity will not stand mathematical examination. The ring must be lop-sided, heavier on one side, to form a planet."

Sir W. Herschel discovered stars revolving in periods of from about twelve years to several hundred years. These are mostly stars shining with their own light, having each a dark companion, which coming between us and it, make what we call a variable star. In the constellation Perseus, in earliest times was seen one of these variable stars, which changes from the second to the fourth magnitude in 4½ hours, and again in the same time regains its brilliancy, which it retains for 69

hours, when it changes again. The Arabs called it Al Ghoul, "The Demon," because of its strange and weird behavior—whence its name, Algol. Twenty-two variable stars of the Algol type exist. Each has a dark companion very close to it. Examining them with higher mathematics some were found to have only two-thirds the density of water, others one-eighth that of the sun's density.

As most of the stars are larger than the sun, they must be formed of gases in a state of intense heat. Mr. Robert's investigations show that five of these double bodies are in absolute contact, forming systems the shape of dumb-bells revolving round each other in periods of from 12 days to 9 hours. Starting from these we find thousands of double stars revolving in a continued series up to the twin stars of Castor, which take more than a thousand years to complete their revolutions. While Mr. Roberts was examining X Carinæ, the two stars parted company, a world was made under his very eyes, and now they revolve at a distance of one-tenth of their diameters.

In 1901, Roberts published the results of his observations in South Africa. Many stars, he says, revolve so that their equators or the planes of their movements are towards us, in which systems one comes between us and the other sun, obscuring its light. In these cases the star is what we call variable. It gets dimmer for a time, then shines out again. Measuring the changes we can tell how long it takes to complete its orbit, then it is but a case of figuring to find their weight and how far apart they are. But we find thousands of stars which vary their light in an irregular way, and when we figure it out, we find there are many stars near together, revolving round a common center. Carrying the observations still further, we find that some of the bodies are dark. That is, some of these stars have mighty planets, cooled suns, revolving round them.

Beta of Lyra, south of Vega, is a variable star, ful-

filling its changes in 12 days 21 hours 47 minutes and 13 seconds. The photographs prepared at the observatory of Stonyhurst College, England, taken each day during its changes, showed this sun goes through remarkable performances. Four sources of light were found in this star—glowing gases giving out their own light, two sources, or bright bodies giving out light with dark lines—and at one stage of its changes other lines were found. Full explanations of these phenomena have not been given.

The spectroscope tells us other stories. When a train is moving towards you the tone of the whistle is higher than when standing still, while when the train is moving from you the tone is lower. The same happens with the stars. When they move toward us, or from us, the lines of their spectra change positions, then we can tell the direction and velocity of the star movements, as well as the materials of which they are composed. This way the two edges of the F. line in the spectrum of the star B. of Lyra shows it is moving toward us at the rate of 68 kilometers a second; its orbit is 74 million kilometers; its center of gravity is 24 millions of kilometers, and it consists of four suns sweeping round their center of gravity, their eclipses giving the changes noted above.

Now we come to a most extraordinary class of stars—temporary or occasional suns, which blaze out suddenly in the heavens within 24 hours, and remain or disappear in a short time. The region called Perseus was photographed, every star there recorded, but within ten days, in December, 1891, a new star, never before seen, blazed up from nothing to the first magnitude, within 24 hours, rivaling the nearby Capella in brilliancy and equalling stars of the first magnitude. The spectroscope was turned on it, photos were taken of its spectra, but the lines changed and shifted so, one print was not like another. What indescribable forces brought this star to this state of intense heat within so short a time? Did

two vast suns come together with a mighty crash? An enormous region of nebulous gases was found to surround this sun; while it shone hydrogen and helium lines flashed out in wonderful brilliancy.

The changes in the hydrogen lines showed it to be moving at the rate of from 500 to 700 miles a second. The vortices, the storms of heated gases, the cyclones of glowing materials, the hurricanes of fiery metals, the tremendous forces shown by the perturbations in the lines proved that the powers of the physical forces which played on this sun were so great, no adjective, no language could express, no human mind could conceive. A whole solar system, our sun with his planets, might be precipitated and lost in this mighty sun with heat so great that every material of which they are made would be dissipated into thinnest gases. The learned say that only the collision of two mighty dark bodies could have caused a phenomena such as they saw. After a time this star dwindled down to the third and fourth magnitude, in three days it shifted to the fifth, and then back again to the third where it remains, its spectrum showing it surrounded with a vast atmosphere of glowing metal gases.

Algol, whose changes caused it to be called the "Demon" by the Arabs, Professor Vogel found has a diameter of 1,074,000 miles, its mass is 4.9 that of our sun, having 0.34 the density of water. The dark companion which circulates round it has a diameter of 840,600 miles, nearly that of the sun, its mass is 2.9 of our sun, and its density one-third that of water. These two bodies are separated from each other two million miles. When the dark body comes between us and the brighter star, it shuts off the light of the latter, and that is the cause of the variations which puzzled the ancients. If Sirius had the same density as the larger body of Algol it would be 1,860,000 miles in diameter.

Castor, called a Geminorum, having the same kind of white light as Sirius, turns round its companion in

346.82 years, its mass being 0.2042 that of our sun. In 1894 Belopolsky found its companion revolves in a period of 2.98 days, going round its larger companion at the rate of 20.7 miles a second, its surface being darker than that of its companion. At the Lick Observatory they found still another sun revolving round its larger and brighter primary, so there are three stars here revolving round each other. The stars *b* Lyra, *u* Pegasus, and *v* Puppis vary their light like Algol, and have dark doubles revolving round them. The first is 21 times larger than our sun and the smaller 9½ times, and they have about the same density as air. The diameter of the larger body of *b* Lyra is 25,000,000, the smaller 19,000,000 miles, and they are 400 times brighter than the sun would be in the same place.

V Puppis of Orion constellation has a mass 70 times greater than the sun, its density is 0.02 of the sun; it changes its light in 1,454 days, and flies through space 380 miles a second. Roberts says his observations show each body of which it is composed has a diameter of 10,500,000 miles, and that these two gigantic suns revolve round each other in actual contact. They are 5,000 times brighter than the sun would be if placed there on the borders of the Milky Way, and it takes their light 1,800 years to reach us.

Professor J. E. Gore investigated the star Mira, "the Wonderful," which fluctuates from bright to dark during a year, at brightest giving out 1,000 times the light of its darkest period. Another changing star in the southern sky varies 10,000 times in its light.

There are hundreds of these variable stars, and men have asked the cause of these changes. It cannot always be because dark companions revolve round them, for they would soon pass across the bright disk. Some say it may be caused by tremendous electric forces, but this is hardy probable. Is it because their disks are like lozenges, and when the edges are turned to us we see them darker? Is it because of tidal action? But as

these are red stars, it seems probable that they are suns in formation into which dark bodies the size of planets or suns are falling and the shock produces the light which blazes up. Stars are red, then yellow, green and blue, according to their heat.

At Harvard University, Feb. 22, 1901, they photographed the spectrum of the variable star, Nova Perci, and two days later took another picture while it was getting brighter. The first photo shows dull bright bands with 5 wide dim stripes and dim bands between the brighter parts. The second prints the whole spectrum brighter in its entire length, lines more scintillating, stripes wider shading into each other. The two spectra are the same in general outlines. But in the latter picture the lines of the metals come out much clearer. What tremendous change takes place in this sun? Within two days it becomes so hot the metals of which it is composed shine out so we can find out the materials of which it is composed. Then within a few days it loses its heat so we cannot tell all its materials. It acts as though you would heat a mass of iron and other material so they will melt, and then let them cool, but remain red-hot for a time, after which you will melt them again. This is an example of the strange actions of many of the changing stars. We may say these stars may be suddenly heated by striking another star in its flight, but what cools them so suddenly to be again heated at regular periods? This is a mystery of the skies.

In two clusters 1,279 suns were counted, but not one changing star was found among them. In three other clusters one variable was found among 1,050, one in 500, one in 100, and in 900 others 132 changing stars were found. As all the variable or changing stars must be double or triple, that is having two or three stars revolving round a common center, as we examine them more closely, we find more and more variable suns, and we are forced to the conclusion of Professor Newcomb:

"It is probable that among the stars in general single stars are the exception rather than the rule."

Now let us see these suns a little nearer. What are they? Of what materials composed? The greatest telescopes man made only show their size, movements, distances, their colors, and hint at their heat. But the discovery of the spectroscope opened up a vast field of spectrum-analysis a thousand times more perfect than any chemical analysis for the examination of matters on our earth. But we can turn this instrument to the stars and it tells the materials of which they are composed, and the mighty changes which are taking place on their surfaces. This department of human knowledge, having its birth almost in our time, is called Astrophysics. The ray of light coming from the star passes through the instrument and tells us the heat of metals, the kind and the nature of the surface of the star which sends its light forth on its journey to us.

Orbs are in different stages of development. The hottest suns are white, the next hotter yellow, then orange, red, dark red and dark stars—that is, suns, but dimly shining like our own Jupiter, Saturn, Uranus and Neptune, planets so large they have not yet lost all their heat. The smaller planets, as our earth, lost their heat from the surface but have fiery interiors; then comes the moon, which long ago lost all its heat because it is so small, then the small moons of the planets, and the little asteroids like round rocky globes floating cold between the stars.

Of the 1,743 stars down to the fifth magnitude, 73% are white, 2% of these have the broad lines in their spectra, 26% are yellow like our sun, have the same materials as our orb of day, and 1% are so cold as to hardly give out a strong enough light to see the lines in the instrument. The researches of the learned, startling in the amount of information they give of the heavens, show that a time was when matter was not, that it is not

eternal, that it was made by the Creator and is directed by His laws.

The light of the third class of stars shows the hydrogen lines not bright, as in the two other classes of stars, but dark, as would be found by passing light through glowing hydrogen in a laboratory. Many of these stars change from time to time, and are called variable stars. Their spectra shine out brightly for a time, and then gradually get dimmer and dimmer for a certain period, after which it will be renewed. This takes place with all variable stars, and they all have regular periods of change.

The reason the lines of hydrogen are dark in place of bright in this class of stars is this. These suns have but comparatively small metallic centers of intensely heated materials, but are surrounded with enormous atmospheres of hydrogen, helium, etc., the light from these glowing gases overpowers the lines from the hot metals, deep within, so that the bright lines of these gases only are seen. Another explanation is that they are entirely composed of these glowing gases. The spectra of these stars were found to be the same as that of the sun spots, and of the vast cyclones which burst from the sun and shoot to the height of 100,000 miles in a few seconds, seen especially during an eclipse. Some of these masses of hydrogen, larger than our whole earth, bursting forth from the sun to this height, were found to be mingled with vapors of magnesium and sodium mingled with hydrogen.

Some spectra are crowded with lines, others have very few, proving that while some suns are made of many different metals, others are composed of few materials. These suns are divided into four classes. The first, called the Sirian, because Sirius is of that class, have only one or two broad lines. The second, the Solar, because our sun belongs in that class, have a large number of lines. The third consists of stars with a number of lines crowded together, with peculiar

"flutings" sharply cut off at the blue end of the spectrum, and shaded at the red end. The fourth gave a very faint spectra consisting of dark lines with "fluting" sharply cut off at the red end of the spectra. The "flutings" mentioned are bands up and down, like pipes of an organ, in the colored band of light.

These tell us the story of suns in different stages of development of light and heat, composed of diverse metals and materials falling into them from the diffused matters of the nebulæ of which they were formed. Look at the Pleiades with your naked eye, and you will see seven stars, but a photograph reveals 1,421 suns. A long exposure showed bright clouds surrounding these stars, that is matter now condensing into these suns, which are now being built up with metals falling in: they are getting hotter; they are in a process of formation as our sun was made. Following out the study we find some stars are just, as it were, being born, some are in middle life, others are old and cool.

Some first-class suns show lines so faint they can hardly be seen, but the lines of hydrogen are so overpowering in amount as to dim the lines of the other metals. These stars are composed mostly of hydrogen gas. These are mostly "white" stars. But hydrogen is not as prominent in all of them. Sirius, which belongs to this white class practically has only the G and H lines of hydrogen and helium in the violet part of the spectrum, proving this star is very much hotter than our sun, and is composed mostly of these gases. All stars of the first class are intensely hot, for their lines are all near the violet end. Sirius and suns of his class are therefore new in the order of formation. The matter of the nebulæ near them having recently fallen in, the intense heat and light have not yet been lost. They are mostly composed of a few metals, for the most part being gigantic globes of glowing hydrogen, with tremendous atmospheres of helium surrounding them.

The second class of stars, called also the yellow, and

to which our sun belongs, are older, and have lost the heat they had when they were bluish-white like Sirius. The cooling has taken place to such a degree that we can see the dark lines of the metals of which they are formed, Capella, *a* Porcyon, etc., are also examples of this class. In them we find iron, calcium, magnesium, sodium, nickel, cobalt, barium, iron, etc., the same as we find them on earth and in the sun—these suns being also surrounded with dense atmosphere of hydrogen.

The lines in the spectroscope caused by the different metals in the stars, their color, position, breadth, number and intensity of these lines and colored bands, tell the story of the materials in the star which shines into the instrument. The density of the medium through which the light passed, the gases surrounding the surface of the orb, the heat, the fiery winds of metallic vapor sweeping over the surface, the chemical changes going on show how the star compares with our sun, and with other stars, its movement from or toward us, or at right angles to us—a thousand things, and a myriad series of movement on the surface of these burning suns are told us by this wonderful instrument.

First the stars were supposed to all have the same heat. But they range from the hottest suns, which give out blue light, to the yellow not so hot, of which our sun is one, down to the red cooler stars, and even to dark stars which can hardly be seen, and even to the darker bodies which we cannot see, but which we know exist because of the movements of the stars round which they revolve, shutting off their light.

The blue stars, or those suns with bluish white light, show a spectrum far towards the violet end of the little rainbow in the instrument, exhibit the colored bands of gases only, as hydrogen, helium and materials in a state of the most intense heat. The yellow stars are not so hot, the lines do not extend so far towards the blue end of the spectrum, and they are found at about the same place as the lines in the sunlight com-

ing from our sun. They show hydrogen, iron, and other metals found in our sun, but in a state of thin vapor of these metals; because of the awful heat no fluid or solid could exist for a moment on these stars. The third group of stars shows short spectra of a red color, while their lines prove that they are surrounded by great atmospheres of carbon with other metals in a state of gas. These three kinds of suns are called "gaseous," "metallic," and "carbon" stars by some scientists, while others name them "Sirian stars," because Sirius belongs to that group, and "Solar stars," because our sun belongs to that class, the others "Red stars," and the unseen the "Dark stars."

Learned men agree that all stars do not always remain in these diverse classes. The impact of one falling into another or tremendous forces of the matters raining down into them, raise their heat, so they may pass from dark to yellow, or to blue stars, and if they are not fed by materials falling into them, they may pass from blue to yellow and to the dark stars by loss of light and heat. The amount of matter falling into them is not infinite, which is absurd to suppose, for then all spaces between the stars would be filled with it. A time will come when every sun and star will have lost its light and heat, all will be dark, heat will cease and life will end on earth. A mighty Mind has marked the time when every living thing, plant, animal and man will cease to live. But when no light or heat will be to sustain life is millions of years in the future.

Lockyer worked out a complete scheme of star growth and decay as follows: Beginning with the nebulæ condensing together forming suns by the materials falling into the center making the suns hot and shining, we pass to stars having fluted spectra showing low temperatures, with their lines of iron, manganese, calcium and other metals. Antares in the Scorpion is one of the most brilliant of these red stars, Alpha Cygni is another, but has more hydrogen and is hotter. Then come Rigel

and Beta Crucis still hotter, and which have hydrogen, helium, nitrogen, carbon and traces of other metals. Hotter still we find E Orionis and two stars in Argo with greater atmospheres of hydrogen, carbon and traces of other metals surrounding them. Then we have Sirius and mighty Arcturus, round which our sun is going, dragging with him our earth and his planets. There is 19 Piscium with its flutings of carbon, and we come to the dim red stars we can hardly see, and at last to the dark stars invisible to us, which like mighty planets circle round the shining suns.

Here we see the romance of the skies, the birth and death of suns, the play of forces on a grandeur we cannot grasp. With lavish might the Almighty presides over the forces of worlds He brought forth from nothing the morning of creation, and hung on the simple laws of movement and weight. He did not abandon them, He still presides over their birth as shining orbs, brightening into suns, and in decay He keeps them by His laws for these millions of years, till they lose their light and heat and become dark again.

Let us lift a little the veil and draw near the wonders of the skies. We are as it were among other worlds, strange, unnatural, on fire. On our little globe nothing gives us hardly a faint idea of the indiscribable forces sporting on these suns, God in millions spread throughout the heavens. The white light of our sun pours its dazzling rays from azure heights of its reservoir, down through our air, and colors every object with its own tints. That is, white light itself shades every object. The real colors are not in the objects but in the light itself. Some things reflect all the light and they are white. Some absorb all but the red and they are red. Thus color is in the sunlight, take away the light and all would be black.

The beauty of the plants, the diversity of the fields, the whiteness of the lily, the scarlet orange azure jewels,

the charming shades of flowers, the plumage of the birds and all the colors of earth, sea and sky are caused by the seven primary colors of white sunlight we see in the rainbow. But all these tints, even more, we find in the suns. Look at that star *n* in Perseus—the fabled hero walking in the Milky Way holding Medusa's head! With the telescope you will find it is a double star, one mighty globe is red like a vast ruby, the other is blue. Red and blue they shine as precious stones millions of miles in diameter, as down they send to us their light which takes more than a hundred years to shine on our shores of vision. But there are stars rising in varied stages of brilliant glory, showing the shades and combinations of the seven colors of the rainbow with all their scintillating tints indescribable. No two suns are alike. A star in the Dragon is a double sun, one orb shining with deep red light while its companion flashes forth in bluish white light. The great central star called *g* of Andromeda is resolved by the spectroscope into an orange colored sun with a companion shining as a beautiful green emerald gem. Vega in Lyra is a blue sun hundreds of times larger than our king of day. A double star of the Lion constellation is formed of two suns—one red the other white. Some systems have red, white and blue suns, others orange, green, purple. In the Whale of Eridanus shine two double stars, one body a straw color, the other blue. In the Giraffe is a blue sun. Orion, Twins and Bootes have mighty yellow orbs, and the Swan has an intensely blue sun. But it would take too long to tell all the colors of the suns.

The writer with the Sultan's son wandered through the double storied Treasury of the Turkish empire, examined the accumulated riches gathered since the house of Osmali left Bagdad; he saw the crown jewels of France in the Louvre; he stood beside the crown jewels of England's king and queen in the Tower of London, flashing forth reflected light from emblazoned

gold work. But what are these cold dead gems compared to the millions of brilliant orbs of sky hung on weight, sending out since creation light and heat and electric wavelets, as blazing crown-jewels, telling the power and majesty of God!

CHAPTER IV.—FALLING STARS, COMETS AND NEBULÆ BUILDING WORLDS.

In heaven there is no up or down. At noon we look at the zenith over our heads, at midnight that part of the heavens which before was over our heads is directly opposite to what it was at noon twelve hours before. The attraction of the earth keeps us on this world. Up is from the earth, and down is towards its center. The heavenly spheres float in space, each attracting matter to itself because of universal attraction; each metal or material has its own proper attraction we call weight. Suns, planets and orbs float in space, each obeying the motions given it at creation. For each there is no up or down except regarding its own sphere pulling materials to itself.

Millions of unseen particles of matter, grains of sand, rocks weighing tons, bodies like little planets float in the vast abysses between the stars. Some go alone, others in clusters, round or long, more form bands stretching millions of miles, containing billions of these little units. They pass round sun and stars obedient to laws of weight and movement.

Getting entangled in earth's attraction, they sweep down through the air, which checks their tremendous planetary flight. The sudden stopping of their flight, and the friction of the atmosphere change their motion into heat; they become red-hot, then fuse at a white beat, burst into fragments, dissolve to dust and metallic gases, leaving a train of light and are called falling stars, aerolites, or meteorites.

August and November, each year, they are more numerous, when the sky is lighted with their brilliancy.

These streams follow comet paths, and the latters' tails are supposed to be formed of these little particles which reflect the sunlight. Each year a hundred thousand millions are estimated to fall to earth. But few reach the earth in solid forms, because they are torn to metallic dust in the high air. We can imagine the number of these bodies scattered through interstellar spaces.

A London professor published a book in which he develops the daring speculation that somewhere in the dark abysses between the stars there may be, unseen to human eye, a dead sun, or dark planet, our earth will one day meet in our vast journey with the sun round the heavens. He figures out what will happen when this supposed body strikes sun or earth. The sun and solar system fly through space round Arcturus at the rate of about twelve to fifteen miles a second, while the swiftest rifle or cannon balls go only about half a mile a second. If this unknown body comes towards the sun at the same velocity, their impact will be at the rate of nearly thirty miles a second, and the stroke will develop a heat which will melt our world, or fuse with fire, turn to metallic gases all materials of earth.

He tells with terrible details how this tramp of the skies will appear before it strikes the earth. It will approach first as another moon, and how helpless men will look on their coming doom. It will revolve round the world obedient to weight. The monster will come nearer and nearer, till at last it will strike the earth, overwhelming cities, continents and seas. Deep down into the very center of the earth it will dive and all materials of which it is composed, and the very mass of the earth will fuse with the terrific heat caused by the stroke. Then this new star, formed of the masses of this wanderer and our earth, will shine as a new sun.

It has been handed down that one day this world will be destroyed by fire. Is there a dark planet, or sun unseen, somewhere in heaven with motion marked out from the creation, which will thus destroy our earth?

Our Father, God, made this little world down in the middle of his material creation where all is stable. He watched over mankind all the ages, and we lay down to sleep trusting His holy Providence.

Will these flaming thunderbolts of Jove
Crush and kill at last the human race,
Like frenzied Titans trying to efface
The work of Him who made us? Were they that strove
'Gainst Omnipotence? What mighty engines drove
Through miles unmeasured of silent space
Those ragged rocks that pass without a trace,
'Cept cloven crag, or cosmic dust, or blasted grove?

Man of daring mind may dream of what you are,
Ye wandering chunks of heavenly iron showers,
Falling, blasting life and blooming bowers
On plain and mount, and into seas and waters far,
Ever sweeping down, rude wrecks of a smashed star,
Stern proofs of other worlds we do not see,
Grim signs that other orbs have ceased to be,
Fear not. To number and danger God has put a bar.

The Creator foresaw size and direction of these wandering bodies, so far he has provided that we were not thus destroyed. In the womb of coming time perhaps in this way the world will be destroyed by fire caused by the awful stroke of a great meteor.

In the neighborhood of the sun, where his attraction is powerful, these wandering bodies are found in great abundance. Learned men hold that the corona of the sun is caused by his light falling on and illuminating the vast millions floating around him. We see the corona especially during an eclipse of the sun. There they are as thick as hailstones. Falling into him perhaps they keep up sun's light and heat, as John Tyndall and Dr. Mayer first suggested, and as Sir W. Thompson (Lord Kelvin) worked out. Falling in one continual rain of metallic solid and gaseous particles, they strike the sun's surface with terrific force which changes their mighty materials into puffs of metallic vapors. The mighty strokes of bodies moving with a swiftness we can hardly conceive keep the sun's envelopes ever

blazing with undiminished intensity. But if they were more numerous, they would heat the sun so life would cease on our earth. If they were too few his light and heat would diminish so we could not live because of the cold. Who measured their numbers, and weighed their masses, made them at certain distances so the sun's energy has remained unchanged through ages past, for life of plant, animal and man, but He who presides over the wonders of the universe?

"That the mighty center of our system should recruit his marvelous expenditure of energy from the tiniest of his satellites; that these fragments, each so insignificant in itself, should collectively supply light, and heat, and life to the great Sun himself, and through him to all his attendant orbs; that it should be through their agency, that the Creator of the universe has ordained that all his creatures should live, and move, and have their being—is one of the most striking conceptions that can be imagined," says R. K. Miller in his Romance of Astronomy.

The falling stars shoot as lines of light across the sky, or down towards earth they fall, till heated to metallic vapors by the friction of the air and the stopping of their rapid flight through space. Sometimes they fall to earth, often burst with crash of a hundred cannons, and the pieces may bury themselves deep in the earth. They are so hot they are near the melting point. We find them, or their fragments, put them in museums as curiosities, and call them meteorites, "in the air" or "lofty."

The greatest cannon cannot throw a ball beyond 3,000 feet a second, but these come into our atmosphere with the velocity of from 10 to 12 miles a second. August 18, 1783, one, seen from Ireland to Rome, being a mile in diameter, burst with a violent explosion and its pieces were ten minutes reaching earth. These meteorites are the remains of the matters and vast materials which fell in and composed the world.

The British Museum has one of the largest collection in the world of these visitors from the sky. The Museum of Natural History. New York, has quite a collection, among them being the largest specimen in the world, weighing many tons, brought by Lieutenant Peary from the far north. You will find a number of "Fallen Stars" nearby.

These bodies coming from the spaces between the stars are always falling over all the earth. Ocean bottoms, and arctic snows are covered with their dust, for most of them are torn into minute particles in their flight through the air because of intense heat developed. They are part of the streams circulating round and sweeping into the sun. Some think they are the remains of comets, or planets, of suns torn asunder by collisions with other heavenly bodies, or remains of matter made at creation of which the larger part has condensed into suns, stars and planets.

The sun's mighty mass attracts the great masses of meteorites in size like small planets, and they fall into his surface. Tyndall estimated that if the earth fell into the sun, the shock would sustain his light and heat for 10,000,000 years. These bodies falling into our sun keep up his heat. The Eternal at creation made just enough of these bodies and placed them in mass and distance so they would fall into the sun in regular streams, rising and falling in periods of 11 years, so they would sustain his loss of light and heat. If too many, or too large masses fall on the sun, our world would be burned up—all life destroyed.

Examining meteorites, we get a good idea of the minerals of the stars and other heavenly bodies. The suns have metals differing from those of earth, although 24 elements have been found in these meteoric bodies caught by earth in her flight through space. Up to the present we have found in meteorites *oxygen*, hydrogen, *chlorine, sulphur, phosphorus*, carbon, silicon, iron, nickel, cobalt, magnesium, chronium, potassium, sodium,

copper, tin, *antimony,* aluminium, calcium, manganese, *lithium,* titanium, arsenic, vanadium. All, except those in italics have been found in the sun. When polished meteorites show peculiar crystalline formations, the iron being mostly in streaks, showing that the laws of crystallization rule in heaven as on earth, and that the mighty Mahematician, God, presides over all matter in heaven as on earth.

Mr. Sorby made a careful study of these heavenly bodies, and his researches show their materials were once in a melted or gaseous state because of the intense heat they were subject to before entering the air. This heat was the result of minute particles of matter striking together by the laws of gravitation, which formed them into large masses. This took place on a large scale in the cases of sun, planets, and stars, when these great bodies were formed by enormous amounts of matter sweeping together, the strokes causing the intense heat, which the sun and stars now have, and which our world had once, before it cooled. Sun and stars are so large they yet show this force in the awful heat and light they throw out. At creation God made just the amount of matter wanted to make the stars, sun, earth and planets the right size. He made this matter just in the places required, that condensing under attraction these orbs might be formed as now we find them.

Mr. Chamberlain figured out the laws relating to tides, caused by the attraction of the sun and moon. He applied his figures to the heavenly bodies and found that a solid world coming near another, without touching, will be torn asunder at a certain distance called " the Roche limit." The nearer these two worlds approach the more rapidly they will whirl round each other, till at last the smaller body will be torn into fragments as a wheel will burst when turned too fast. As some of the meteorites show a planet's structure, they must have come close to a star or planet and been torn asunder. Some think the meteorites and the little asteroids be-

tween Mars and Jupiter once composed a large planet which was thus torn to fragments. If our earth went wandering from its path round the sun, or if a large planet like Jupiter, or a star came near us, our earth would be broken up into small fragments. But this awful calamity will never take place as far as we know. For the solar system shows no signs of disturbance or destruction while ruled by the laws of mathematical mechanics on which God poised the orbs.

Between our solar system and in the spaces between the stars are floating peculiar erratic bodies like "tramps" of the universe. They are called comets from *coma,* "hair," because of the tails most of them have. Some belong to our system and circulate round the sun, some pay us visits at stated times from far-off systems, some come into our solar system, sweep round the sun, pass into the spaces between the stars never again to appear, while it is supposed countless millions are wandering through the universe never to be revealed to man.

The remarkable appearance of these bodies, the irregular visits of these meteorites, their diverse movements, their sudden appearance, their brilliancy in the firmament, the gigantic trains of light they throw out as they near the sun, the wonderful lengths of their tails as they sweep round and close to the orb of day, the sudden diminishing of their light as they wander off into space, extinguished in primeval darkness from which they suddenly emerged—all these have shrouded them in mystery. In ages past they were looked on with dread as signs of the world's end, or of calamities. Well the writer remembers the great comet of the summer of 1858, which blazed out every night after sunset in the west, its tail stretching almost across the whole sky.

Most comets have a head and tail, the latter generally behind, but some carry their tails before them. The head, called the nucleus, generally grows smaller as it approaches the sun, while the tail grows in length and size, sometimes shooting out a million miles an hour.

The comets' tails generally stretch away from the sun. When the comet sweeps down and around the sun the tail keeps turned away from our luminary, so that the tail must sweep through millions and millions of miles an hour. How solid matter, liquid or gas, can do this we do not know. But as the theory of floating materials of dust round the sun has been accepted, some think that the head of the comet concentrates the light, so that after passing through the head, as through a great lens, the particles floating in millions in space are illuminated as the comet sweeps around the sun.

The wandering bodies are subject to the laws of weight similar to planets and suns in their paths. The planets go round the sun, not in perfect circles, but in elongated curves. Now if we suppose these ellipses or curves be stretched out very far, like a giant circle with its two sides compressed so it will be a long and narrow hoop, and place the sun near one end, in the middle of one of the half circles, we would have a comet's path. In higher mathematics this is called a parabolic circle. The comets follow the parabolic path while the planets follow the ellipse. We can therefore find the path of every comet as soon as we know but a small part of its movement, for all the millions of heavenly bodies are ruled by strictest laws of figures the Creator gave them with the force He implanted in them.

What are these heavenly wanderers made of? The spectroscope shows they contain gases, especially carbon, glowing with heat. But within the globe of comet gas great numbers of solid particles, dust, lumps of metals, stones, rocks fly together, heating the gases so they glow. They are continually falling apart, tearing asunder and coming together again, thus keeping up light and heat. These solid particles are far apart, so the light of sun and stars can be seen through them. The tail spreads out as a thin flat wedge, from the head far out into dark space. We cannot see it when the flat side is towards us, but we can, when its edge turns to us. The head is

mostly formed of gases glowing with the heat of continual great collisions which changes the solids into metallic gases, as we see when meteorites strike our atmosphere. The polariscope shows they shine with reflected sunlight. Many theories have been broached to explain comets.

What would happen if a comet struck our earth? Arago figured out the chance is as one to three hundred millions. If the comet of 1832 had been a month sooner it would have struck the earth, and the blazing vapor of carbon and metals would have scorched every trace of life off the surface of our planet. Even if a comet formed of gases met the earth we would all die, for our atmosphere would be heated so the surface of the earth would melt. Even if some people escaped in caves, they could not breathe the gases and would die in a few moments. Laplace thus describes the result:

"It is easy to represent the effects of the shock produced by the earth's encountering a comet. The axis and the rotation changed; the waters abandoning their former position to precipitate themselves toward the new equator; a great part of men and animals whelmed in a universal deluge, or destroyed by the violent shock imparted to the terrestrial globe; entire species annihilated; all monuments of human industry overthrown—such are the disasters which the shock of a comet would necessarily produce."

Miller says, "Whatever the cometary material may be, it is not likely that it will be the same as that which composes our own atmospheric air, and as our lungs are not adapted for breathing any other kind of gas, the probable intermingling of our atmosphere with the substance of a comet, would be at once to render the former utterly unfitted for the support of animal life." In the long course of the ages our race lived on this planet, a comet has not struck it. We are forced by the probabilities that such a thing will never take place, for we are looked

after by a Supreme Being who guards His children from such an awful fate.

The elder Herschel gives thirty-three classes of nebulæ, of which we cite the chief. Extensive nebulosity, some of which spread out over five or six square degrees and one of which occupies nine degrees. Milky nebulæ with condensation in the center, showing where the future sun of this system is to be. Nebulæ of irregular figure, which show where planets are to be formed when the matter falls into these different places. Round nebulæ like vast globes, but showing no nucleus or condensation. These are seemingly young systems. Nebulæ with bright centers where the matters have begun to condense and form a sun for each. Nebulæ with bright nucleus in the center proving that they are more advanced in world and sun formation than the former. Nebulæ which have drawn nearly all the matter into their centers which are very bright. Nebulæ which show that the sun and planets in them are almost formed. Nebulæ which very nearly approach the appearance of stars.

In these classes the reader can see that the nebulæ range from the beginning of their creation up to the formation of a central sun and planets, as our system of sun and his planets were formed. We see before our eyes the condensing and formation of worlds, suns and stars under the very laws which ruled in the creation of our earth, sun and planets.

At the present writing more than 10,000 nebulæ have been discovered and new ones are constantly being found. They are nearly all in the regions outside of or between the great ring of the Milky Way. Dr. Isaac Roberts, who has perhaps the best telescope for photographing stars, and who devoted most of his labors to the study of these heavenly bodies, says that most of them show spiral forms with dense crowded matter in the center, that they are studded with stars, and that these stars follow the curves of the spirals. Here are thousands of

world and sun systems forming into globes. The spirals are so marked a feature they show in the present arrangement of most of the stars. They are found in all parts of the heavens, proving that all the heavenly bodies took their rise from spiral nebulæ, whose materials were absorbed by them.

Dr. Roberts offers several problems relating to these bodies. He finds they are composed of faint clouds, often of vast extent scattered in many parts of the sky. Sir W. Herschel alone recorded the positions of fifty-two such regions, but recent astronomers opened up thousands of such places, especially by photography, which records bodies eye cannot see with telescopes. Roberts concludes that they are gases interspersed with solid particles—all undergoing condensation into globes like suns and planets.

Lord Rosse, with his great reflecting telescope, first discovered vast systems of suns clustered, not only in constellations in round condensing spheres in groups more or less regular, but also according to a distribution which reveals gigantic forces playing amongst them. He discovered that stars distributed in long curves or spirals, are result of matters condensing from the gaseous nebulæ of which they are made, by the action of universal gravitation. From the chief centers of these tremendous systems of suns, a multitude of spirals, formed of numberless suns or nebulous materials, issue from the bright nucleus, or brilliant centers spread out on all sides, gradually losing their brightness and dying away as trains of phosphorescent vapors. Humboldt thus writes of the Magellanic Clouds near the south pole of the heavens:

"The magnificent zones of the Southern heavens comprised between the parallels of from 50 to 80 degrees, are the richest in nebulous stars, and irreducible clusters. Of the two Magellanic Clouds which lie so near the Southern pole, this pole so poor in stars that it might be called a waste country, is the largest nebulæ.

It appears according to recent researches to be a wonderful agglomeration of spiral clusters of large and small stars and irreducible cloudy nebulæ, whose general brightness lights up the telescope field of sight and forms the background of the picture. The aspect of these clouds, the brilliant constellation of the Ship, Argo, the Milky Way, which extends between Scorpion, Centaur, the Southern Cross and the picturesque aspect of the whole Southern sky have produced on my mind an effaceable picture."

Lockyer's studies in physics show that when solid bodies like meteorites fall together by attraction, they fly so swiftly and strike together with such forces, the heat develops the white and electric lights which they glow. He also points out that under this attraction matters in the sky form into spirals. For any collisions between unequal masses of matter coming together without a central body to draw them, would be forced to revolve in spiral motions. In this way, directed by these laws, the matter of the whole universe united by attraction into the great constellations we see every bright night as groups of twinkling stars.

Every particle of matter in the universe attracts every other particle. Thus because the earth attracts matter everything is heavy. But left to this law of weight, or of attraction alone all matter would fall together, and form one tremendous mass—one mighty globe of awful size and heat. But with the force of attraction there was given each particle of matter a movement towards another place, and with these two motions smaller particles of matter went round other larger masses till all condensed into globes of fire and light we call stars. Now, where did they get this movement? Wallace says:

"How these motions originated and are now regulated we do not know; but they are there, and they furnish the motive power of the collisions which, when affecting the large bodies or masses of diffused matter, lead

to the various kinds of permanent stars; while when smaller masses are concerned these temporary stars are formed, which have interested astronomers in all ages. It must be noted that although the motions of the single stars appear to be in straight lines, yet the spaces through which they have been observed to move are so small, that they may be really moving in curved orbits around some central body, or center of gravity of some aggregation of stars bright and dark, which itself may be comparatively at rest. There may be thousands of such centers around us, and this may sufficiently explain the apparent motions of the stars in all directions."

Chamberlain suggests an origin for spiral nebulæ and the swarms of meteorites and comets. When two bodies come near each other, the larger will tear the smaller into fragments because of the tremendous strain exerted by the larger, and this will take place at what is called the Roche limit. The attraction of the sun and moon causes the tides in earth's ocean and atmosphere, and no doubt in the interior melted mass of our earth. But it is not powerful enough to drag the waters and air from our earth, therefore the tides flow back and forth day by day. But when stars come very near each other the mighty strains produce an explosion, tearing bodies apart with a tremendous crash, and the matters fly off in spiral forms on each side of the disrupted bodies. Now we find all the well-developed star spirals have two such arms opposite to each other, as shown in M. Comæ 100 and M. Comæ 51, as well as in other nebulæ.

Stars range like lace work. Photographs show in some cases groups of 6,000 and in others 10,000 stars. In Hercules is a star called 13 Messier, just visible to the naked eye as a hazy star of sixth magnitude, but the great Lick telescope on Mt. Hamilton, Cal., shows it to be composed of thousands of stars forming a mighty globe-like system. There are thousands of such star

clusters scattered over the heavens, being more numerous in and near the Milky Way.

Proctor and Sidney Waters marked on maps of the northern and southern heavens the star-clusters and nebulæ, and they are seen thickly strewn over the entire course of the heavens. In the Milky Way—especially along its margin—in all other parts of the heavens such condensed clusters are but thinly scattered and at distant intervals, with the exception of the Magellanic Clouds of the southern heavens where they are densely grouped. One-twentieth of them only are found outside of, or far from, and nineteen-twentieths of them are on the borders or within the Milky Way. They are thus in or near the great fundamental ring of the heavens.

Higher telescope powers resolved many nebulæ into star-clusters, and it was first supposed they were all made of stars. But when the spectroscope was turned on them, they were found to be wholly or partly shining metallic gases of vast extent, having stars interspersed. The nebulæ seem to be like comets' tails, or glowing gases condensing into stars. Thus science shows that worlds are now being made, and this is going on under our very eyes, as the world and sun and moon and planets were made in those far-off days when the world was made of these metallic gases called "waters." "And God said, Let there be a firmament made amidst the waters, and let it divide the waters from the waters. Let the waters that are under the heavens be gathered together into one place, and let the dry land appear." —Gen. i. 6-9.

The spiral nebulæ in Canes Venatici is a most beautiful object. All the spirals start from a bright center and sweep from left to right, forming a gigantic wheel of bright light like a bright burning wheel we set spinning at a July Fourth exhibition of fireworks. The nebula in Lyra is a great dense ring or wheel, a thick rim without spokes, the hub being a dense bright cloud within. The great nebula in Orion show spirals with

numerous stars within the clouds. But the large Magellanic Cloud shows slighter spiral forms.

Now what are these heavenly bodies formed of? Father Secchi, Huggins, Vogel and others set out to answer this question. When they turned the spectroscope on them, they found some nebulæ to be clusters of stars not differing in their materials from other suns. But most of them were found to be composed of gases especially hydrogen, helium, and nitrogen. Of the 70 examined by Huggins about a third showed they were composed of gases.

The star O in the constellation Centaur—seen with the naked eye—a small glass shows it as a bright star. But when photographed with an exposure of forty minutes it is found to be composed of about 6,000 stars grouped in a globular form. The center is fairly packed with them, where they are so close they almost seem to touch. They get thinner and thinner towards the outside of the globe. Although they seem almost touching, they are not so near, but one star is seen far beyond almost in a line with the other. The distance across this globe of stars is trillions of trillions of miles, and they circle round each other.

Let us turn our telescope to Orion, with Sirius and Aldebaran on either side, refulgent in their splendor. Below the second star of the belt, Huygens in 1656 first found a remarkable white cloud, which seemed to him an opening in the sky. "I accidentally," he says, "observed that in place of one of these stars, which occupy the center of the group, there was a dozen of them, a result which is not rare to obtain with telescopes. Of these stars there were three, which like the first nearly touched each other, and four others seemed to shine through a cloud, in such a manner that the space which surrounded them appeared much more lumiuous than the rest."

Since that time, this part of the heavens excited intense curiosity among astronomers. Some thought it was

formed of immense phosphorescent clouds, others of such a vast number of stars not separated by the highest powers of the glasses up to that time, which Herschel compare to the head of a monstrous animal, with gaping mouth and nose, stretched out like an elephant. It occupies a space apparently as large as the full moon. When we think of its billions of miles distance we can imagine its extent.

But the changes taking place in it astonish us. Within a half century it became brighter in some places and darker in others, showing it to be the seat of formidable disturbances amid its mighty conglomerations of suns, planets and cosmic dust of which it is composed. The director of the Russian Observatory wrote: "The general impression that I have received from these observations is, that the central part of the nebula is in a state of continual agitation like the surface of the sea." When we know that this nebulæ is so far away from us, that it takes light years to come, flying at the rate of 181,000 of miles a second, that we can see the whole of this vast object change from year to year, that its central part waves back and forth like a vast, tremendous sea lashed by winds and cyclones, we can have but a faint idea of the inconceivable forces, which set the materials in motion on such a stupendous scale. For Sirius, a little down to the left, is 1,375,000 times the distance from us to the sun. What therefore must be the movements in this nebula we can see at such a distance?

We mentioned Sirius, whose light takes nearly 22 years to reach us. Thus he is named from Osiris, the Egyptian god, for he announced to them the rising of Nile waters; like a faithful dog he warned them to prepare for the overflowing floods, hence has been known as the Dog Star. But since these days of old, when men untold, worshipped stars, the precession of the equinoxes changed the position of the earth with regard to Sirius, whose rising then took place on June 20, for

now he appears above the Egyptian horizon on August 10.

Dr. Roberts devoted years to photographing nebulæ, more than 10,000 of them are known, new ones are being discovered, and they can be studied in the photo prints at pleasure. Many of them are spiral in form with a dense center, where their matter is condensing, most of them being studded with stars into which their matter is falling. But these stars are always more or less symmetrical in arrangement, while outside the nebula these stars extend in lines showing where once, way back billions of years ago, the gases and materials extended before they condensed. All stars will be found more or less in straight or curved lines through the sky, proving that once the universe was filled with one mighty nebula, the matter of which condensed and formed the stars. Thus God made the universe in that far-off time, and gave it his laws of motion and attraction. Following these laws, every orb, and sun and planet, and nebulæ were made. There was therefore no form nor light when matter sprung from nothingness, chaos and eternal night. "And the earth was void and empty, and darkness was upon the face of the deep." Gen. i. 2.

Dr. Roberts finds these faint clouds of nebulous matter oft of vast extent studding parts of the sky. Sir Wm. Herschel alone records the position of 52 such regions, and recent photographs show how numerous they are. All are condensing into worlds, and suns and systems in various degrees of formation. Lockyer says collisions of meteorites with each dust cloud would produce the spiral, and other forms, where one body was much larger than the other, when they came together with a mighty clash of worlds. We have no idea of the awful size of these bodies, of the mighty forces sporting in the heavens, of the amount of matter the Almighty made.

According to the distances the nebulæ were made from each other, and according to the amount of matter they

contain, they condense into varied forms. Some are very irregular, like patches of cirrus clouds; large numbers are in spiral form, some are ring-shaped, otherwise involved in a white cloud, with a bright star in the center, or separated by a dark space of varied shape, from ring to central star. Stars, again, are strung along the spirals of the nebulæ, like bright beads on a string. Some show beautiful regular outlines with quite bright stars in the center, as M. 100 Comæ, and I. 84 Comæ, or as in the straight streaks of the Pleiades. There are so many nebulæ in ring-form, and the Milky Way is a mighty ring that we conclude that it too was formed of matter denser on its outer edge, and this matter condensed under the laws of attraction into the mighty suns of which the Milky Way is composed.

We have led the reader along so he can see how this universe was made. The heavenly orbs are distributed into three great classes—the Milky Way, the stars, and the nebulæ.

Nebulæ show many and remarkable forms. Some are quite irregular, as that of Orion, and the Keyhole in the southern sky; more are of spiral form, as those in Andromeda and Canes; others are ring-shaped, as those in Lyra and Cygnus, while many show disks like mighty planets. But all exhibit matter condensing into mighty suns and systems of worlds. Herschel catalogued 5,000 in 1864; up to 1890, 8,000 were described, but photography shows many hundreds of thousands of nebulæ. Stop to think that so many worlds are now being made. The Eternal, we call God, is giving us lessons we seldom learn. His boundless power shows us in thousands of cases how He made this little world for us.

The spectroscope proves the nebulæ to be gaseous, that is metals so hot they are in a state of gas very like the brilliant white stars. But it also shows a green line not produced by any element found on earth. What that metal is, thus far we have not found. Many nebulæ,

especially far from the Milky Way, resemble vast comets in their form and structure.

Now let us see what are the materials of these nebulæ. And first we lay down the principle, that all discoveries show that the heavenly bodies are made of the same materials as our earth—matter is the same through the universe. If some materials have been found in the heavenly bodies not yet discovered on earth, time will show.

Turn now the spectroscope on them and analyze their materials. They are cloud mists fine as flour, metallic gases, metals ground to powder pulverized rocks, carbon, hydrogen and other gases. Moving with the swiftness of planets they come together, strike each other with awful force—flying at from 10 to 100 miles a second as though shot from the Eternal's cannons. Thus ever and for eons of ages they mix and mingle, strike and sway, sweep and swing, wave back and forth, grind and melt, cool and heat, the forces being beyond our conception. They glow with white heat from the stroke, or shine with electric light like the northern lights in winter round the frozen poles of earth.

Gases and metals covering spaces thousands of times larger than from here to the sun, heated hotter than the sun for their light is white, while his is yellow, cosmic dusts, groups of meteorites, floating mountains, rocky masses like the moon, masses large as earth, planets, great as Jupiter, millions in numbers, sweep and whirl round and round, waves of materials measured in millions of miles, like a boundless ocean sway back and forth as down to a central larger mass they fall. Ever and on go the mighty movements, chemical action, uniting, separating particles, tearing asunder and building again—all held by weight. Countless million years will pass, but only a tick in the Almighty's clock, and lo, a systems of suns will then come forth from the womb of time. Thus beyond the dream of romance, we see suns

and systems being created before our eyes in the nebulæ.

Sir N. Lockyer, and famous European and American men of science passed years of study, followed higher mathematics, worked out the problems of the nebulæ—their nature and movements—and we have condensed their results in the above. These men but followed out the footprints of the mighty Mathematician, our Creator, God, in His material creation, and to them be all honor and glory, they could not say there is no God.

For the wonder of it is, these tremendous streams, and globes, and masses of matter, and gases known as nebulæ, now making systems of sun and planetary systems like ours, do not come together as one great mass of matter, which they would if left to weight alone. They form into suns and globes, which go round each other all the time, according to the processes of arithmetic, and higher mathematics. Who is the wise Power who presides over their movements? There must be a Wisdom different from these fiery globes and vast expansions of matter, who lays down their limits, their directions and the velocity of their movements, because all those movements are founded on figures.

SECTION II.—THE WONDERS OF THE SOLAR SYSTEM.

CHAPTER V.—THE WAY OUR EARTH, SUN AND PLANETS WERE MADE.

We saw that even in our days metals, gases and materials of nebulæ are falling together, condensing into systems of suns. Science says all materials composing the solar system, now condensed into earth, sun and planets, once formed a nebula, or vast cloud of dust, metallic vapors and gases, extending far beyond the orbit of our outside planet, Uranus. These materials were not created spread equally, the same in all places. They extended like clouds with empty voids between them where there was no matter, or it was not as thickly made. Where Providence saw planets would condense, He made matter in greater amounts. These denser materials drew in the surrounding dusts and gases, and thus built the planets. In the center of the vast shapeless mass the materials were dense and these now compose our sun. In certain spaces matter was thickly spread, and the earth and planets resulted from their condensation.

Science loves to try to trace the natural laws back to the beginnings of this vast globe of misty deeps, when the Eternal in His might brought them forth from nothingness and eternal night. All discoveries agree with these words: "In the beginning God created heaven and earth. Gen. i. 1. And the Hebrew word is *erets*, "earth," ground, "soil." How expressive this is of the dusts, and mists of which science says the orbs were made!

The universe was filled with matter without movement; chaos and dark night brooded over nature. The cloudy dusts were motionless and all was dark. No sun or planet or orb then was there. "And the earth was without form, and void, and darkness was upon the face of the deep." Gen. i. 2. How scientific that description is of the universe before it was given motion which produced heat, light, electricity and the natural forces!

What is the meaning of these words we translate without form, according to the latest discoveries of our day. The Hebrew is *tohu* "vacancy," a "ruin," that for void is *bohu,* "emptiness," for darkness we have *choshek,* "without light." The Bible story shows a void, vacant, empty, dark, like a ruin, without order, without light. Thus the Creator made matter. Our latest discoveries bear out this statement. Every science says this was the way matter was in the beginning.

The sun with its light, heat, electricity, magnetism, and other forces, its relation to earth and planets circling round, the movement of each body on its axis, the sun going round on its axis in 25 1-3 days, the earth in 24 hours, the planets revolving in their own time—these bodies, of the solar system, help us gain a knowledge of the millions in number of other heavenly systems. Let us first see our sun and his planets.

We see that vast body, a ball of fire hung in heaven, each moment giving out tremendous force. We find the larger planets, as Jupiter, Saturn, etc., are red-hot orbs, with every metal melted. Our moon's surface is dotted with extinct volcanoes, which once belched forth fire. The solid granite crust of our earth shows that once it was melted and in cooling crystallized, and the interior of our planet is a fiery mass. Every heavenly body shows intense heat now or at former time. Where did this heat come from? We are now at the origin of worlds.

Oft in olden days poets sang of the universe, made from

chaos and dark night. Their idea in the main agree with Moses' words, telling of the time when "the earth was without form, and void, and darkness was upon the the face of the deep." In Hesiod's pages Ovid sings of the birth of nature and Dante also tells the story. Milton elaborates in these words:

"A hoary deep, a dark
illimitable ocean without bound,
Without dimension where length, breadth, and height,
And time, and place are lost, where eldest Night,
And chaos, ancestors of Nature, hold
Eternal anarchy, amidst the noise
Of endless wars and by confusion stand.
A wild abyss,
The womb of Nature and perhaps her grave.
Of neither sea, nor shore, nor air, nor fire,
But all these in their pregnant causes mixed
Confusedly . . . Chaos, umpire, sits,
And by decision more embroils the fray,
By which he reigns; next him, high arbiter
Chance governs all,"

But now the "Spirit of God moves" over the face of "the waters"—metallic gases; dead, dark and moveless matter takes on force. Chaos ceases, order is born, light comes forth. Then, under the impulse given the universe by God, the suns and worlds move, begin to form. We can trace matter, star, sun, planet, comet, nebula and meteorite back by laws to that time when God gave them force and sent them in the mighty orbits they still follow. Did you say these heavenly bodies were always, that they are infinite in number that an Intelligence eternal in wisdom and might did not bring them forth and fix their laws and sent them on their journeys?

Tennyson, Poet Laureate, in the "Princess," thus sums up the formations of sun and planets:

"This world was once a fluid haze of light.
Till toward the center set the starry tides,
And eddied into suns, that whirling cast
The planets."

In the British Museum the writer stood beside cases containing Tablets discovered once ornamenting temple and palace walls in plains of Babylonia. They are of red baked clay like bricks from 6 to 8 in. long, and about 4 to 6 in. wide. Before being burned they were covered with arrow-headed letters called cuneiform characters. Beside each tablet is a translation by Dr. Smith. They relate the Creation, the Fall of Man, the Tower of Babel and matters of the history given in Genesis. The fifth tablet, relating to Creation, has the following Legend:

It was delightful all that was fixed by the great gods,
Stars their appearance (in figures) of animal he arranged,
To fix the years through the observations of their constellations.
Twelve months of stars in three rows he arranged,
From when the year commences unto the close.
He fixed the positions of the wandering stars to shine in their courses,
That they may not do injury, and may not trouble any one.
The positions of the gods Bel and Hea he fixed with him,
And he opened the gates in the darkness shrouded,
The fastenings were strong on the left and right.
In its mass he a boiling (in lower chaos)
The god Uri (the moon called Ur) he caused to rise out the night he overshadowed,
To fix it also for the light of the night until the shining of the day.
That the month might not be broken and in its amount be regular,
At the beginning of the month, at the rising of the night,
His horns are breaking through to shine on the heavens
On the seventh day to a circle he begins to swell,
And stretches toward the dawn further
When the god Shamas (the sun) in the horizon of heaven in the east.

The rest of the tablet is broken and mutilated so but few words can be made out. Stripped of fancy and fable how like these words are to the Biblical account, "And God said: Let there be lights made in the firmament of heaven to divide the day and night, and let them be for seasons and for days and for years. To shine in the firmament of heaven and to give light upon the earth." Gen. i. 14, 15.

Proctor, in his "Other Worlds than Ours," sums up the ideas of the learned, and reduces to a system the discoveries and figures of astronomers. He says all re-

searches show the space now occupied by our sun and planets, as well as the spaces, between the stars were once occupied by vast quantities of gases and metals in a state of vapors, clouds or mists. But these matters were not dispersed through the universe in an even way. They were denser in some places than in others. When given movement and attraction, planets and suns condensed in these places where matter was more dense, or thickly spread.

But these places between the stars where matter was more thickly strewn were not thus filled by chance. An overruling Providence marked out and fixed exactly these special places. As the matter began to attract, the materials swept down towards the centers in each special place and thus they formed the planets and suns. As the particles of matter, by the universal law of weight, fell down into the heavier masses, the impacts developed great heat. This was the origin of the heat of suns and stars. The earth and moon surfaces show that once they were intensely hot, but by lapse of time they cooled. As heat is a mode of motion, the result of movement, this heat came from the tremendous strokes of these particles falling into and on the surfaces of earth, planets, sun and stars.

When we apply the rules of probability to these laws presiding over the formation of worlds, we find it is utterly beyond all calculations to suppose that these millions of shining orbs were made in their places by chance, and measured and weighed and placed where we find them now going round. For if there were no Power who made matter in the places where it would condense into worlds and who gave it laws to rule the stars, chaos and eternal confusion would reign. Planets would fall into suns, suns would sweep down into larger suns, and under attraction alone, all would combine into one mighty, tremendous mass condensing all matter in the universe. There was therefore a Mind, eternal in Wisdom, who made matter in these places, and gave it these simple

laws by which it condensed into planets and suns. A study of the heavenly bodies forces each one not insane to say there is a God who presided over creation, who still rules matter.

Led by higher mathematics—following figures we will not now spread on our pages—Proctor shows that the largest union of matter would take place at the outside of this revolving nebula or globe of metallic mists forming the planets and sun. The more it condensed, the larger would be the masses separated from it. This is just what we find. For Neptune, Uranus, Saturn and Jupiter, the largest planets, are the farthest from the sun, while Mars, our Earth, Venus and Mercury are the smallest and nearest to the sun. This took place because the sun in the center, with his great mass of matter, attracted the greater part of the materials nearest to him, after the large masses far removed separated from this revolving globe of mists, dust and gases which broke up into the larger planets.

This is the result of the latest instigations of the learned. For all through the universe movements of matter follow their laws and act according to mathematics.

The circular motion of each sun and planet produces two forces, one tending to force the orb away when it turns too fast, the other to fall into the larger body round which it revolves when it goes too slow; one is the centrifugal the other the centripetal force. These forces just balance each other in all the heavenly bodies.

We know how a wheel turned too fast will burst with force according to its swiftness, how whirling balls make a governor for an engine regulating its speed. If the world went round the sun once in two years it would in time fall into his surface; if it went round him in six months it would fly away into the spaces between the stars. But we swing round once a year and the impulses to fly away and to fall into the sun just balance each other.

Suppose our earth had only half its weight, or the sun had twice its mass, or we were twice as far away, or swung round him nearer, or farther, our world would have been destroyed within historic days. For it would be hurled far out into the deeps between the stars, or fall into the sun. How we admire a beautifully working machine! But who realizes the wonders of our world resting on nothing, rolling round once each day, gyrating round the sun each year with forces so nicely poised and balanced it goes on counting days, seasons, years, ages?

The Almighty made just enough matter, in the exact place in space where a sun or planet was to be formed by materials falling in to form its mass, gave each metal its weight so all would compose our world weighing just this amount of tons, placed our earth just that distance from the sun, gave it just this force or rapidity of revolution that it might go on forever.

But this He did not only with our earth, but also in every planet, and with the millions of suns. To do this he weighed every particle of matter in earth, and planets and suns and comets and nebulæ, measured out their distances one from another, gave them just the motion required. With His infinite mathematical mind he laid down their laws, hung them on figures of arithmetic, algebra, conic sections and all the studies we follow in universities.

Will you say all this came by accident? The probabilities are that in one case out of millions chance might place a planet the right distance from a sun. But every body in heaven is hung according to these mathematics and thus they do not clash together. Deeper still we see the wonders. For not less than 500 millions and perhaps a 1,000 millions of suns sweep round each other according to these laws, not counting the nebulæ and comets and bodies we do not see because they are dark, and which we know exist because they cause perturbations in the planets by turning them from their course.

Still wonders rise and pile on marvels. For of these 500 millions of suns few of them are single bodies, nearly all are double, triple, quadruple clusters, etc., two, three, four, or many suns revolving round a common center of gravity. It was necessary to weigh each of these bodies, to know the exact distance to place them from each other, and give them the right rapidity of motion. We weigh them when we know their movements shown by the spectroscope which tells their light, heat and the metals composing them, but we are only going over the works of the Creator, who hung them on these simple laws, and placed them there to tell us a little lesson of his Almighty Power.

The learned author of "The Moon Considered as a Planet, as a World and a Satellite," says, p. 29: "The Divine Will that made the earth made the moon also, and the means of working were the same for both. The geological phenomena of the earth afford unmistakable evidence of its original fluid or molten state, and the appearance of the moon is unmistakably that of a body once in a molten or igneous state. The enigma of the earth's primary formation is solved by the application of the dynamical theory of heat. By this theory the generation of cosmical heat is removed from the quicksands of conjecture, and established on the firm ground of direct calculation, for the absolute amount of matter is deducible from a mathematical formula." Mayer computed the amount of heat the matter of the earth would have generated if it had been formed originally of only two parts drawn into collision by mutual attraction, and has found that it would be from 32,000 to 47,000 deg. C. The temperature of melting iron is only 1,500 deg. C.

The celebrated Holmholtz figured out the amount of heat generated by the condensation of all the matter in the solar system, sun and planets, and finds it enough to raise a mass of water of the same size to 28,000,000 degrees C. Father Secchi and Tyndall estimate the

heat of the sun as 10,000,000 degrees. We find, therefore, that the present heat of the sun and the original heat of the planets which has been for the most part lost, came from the weight of the matters falling into these suns and planets, which began to fall down after God gave attraction to matter at creation. The planets, being smaller, cooled, the suns we call stars, being larger, preserved their heat and still give out light. Therefore we trace back through the laws of nature light, heat, electricity and the natural forces into weight, called attraction. Every movement or change in sun or planet or heavenly body, every move of living plant, animal or man came originally from the Creator, the Primeval Force and Fountain of movements in nature. Therefore motion, or force, cannot be destroyed.

Men who dug deep in the science of the stars, say that the probability that by accident they happened to occupy the positions they now have, that they got the movements and the orbits they follow and pursue is unthinkable. Leaving aside the millions of suns we come now to study the bodies of our solar system. Did it happen that the planets gyrating round our sun from west to east happened to get those movements by chance? Let us see.

Eight planets having 136 moons or satellites, with 500 little planets called asteroids making 636 bodies, not counting comets and meteorites, compose our solar system. They all go round the sun from west to east. Did this happen through an accident?

"For it would be manifestly unreasonable," says Professor Proctor, "to regard our system as one in which the original arrangements were so fortuitously happy, that it has continued to exist as a system. For we find that the probability of these arrangements so existing by mere chance is exceedingly minute. Now how small this probability is may be inferred by considering only the motion of the planets in one direction. Therefore, by the laws of probability, the chance that even 144 planets would revolve in that direction is represented by

a fraction, whose numerator is unity, and its denominator is 2 raised to the 144th power. Now 144 times the logarithm of 2 (or 3010300) equals 43.3483200 showing that the above denominator is a number of 44 digits beginning 2230077 with 37 digits to follow. (That is 2230077 with 37 ciphers or noughts following. This inconceivably enormous number represents the odds to 1, against the observed arrangement being the result of chance, even considering the only result of several mentioned above, all of which present the same order of improbability."

Thus the probability of one planet having obtained its motion from west to east by chance or accident is as one to 2,230,077,000,000,000,000,000,000,000,000,000,000,000. Therefore this planet must have received its movement from a Mind which directed it. But there are 144 regular planets and satellites and 500 little asteroids in our system, and this law of chance must be applied to each, making 144 added to 500=644 multiplied against the chance that each happened by accident, or haphazard, to get its direction from west to east. But there are 500 millions of suns we see as stars, nearly all the stars are double, some are triple, and thousands have dark bodies circulating around them. But when we apply this rule of chance to them we are simply lost in figures. Miles square of paper covered with figuring would not hold them. The mind lost in mathematical truths, our truest reasoning force us to stay an eternal Intelligence directed the movements of the heavenly orbs.

Light, heat, electricity, magnetism, attraction, weight, etc., are modes of motion. The universe is at last reduced down to two things, force and matter. We ride in a trolley car moved by electricity, heated and lighted by the one same force which comes from the burning coal or falling water, and that force came from the sun's light and heat stored up. Every movement on our earth comes from the sun. But where did the sun

get the tremendous forces he has been sending out for untold ages, and still pours down, and whence came the heat of earth and planets and stars and Milky Way?

A French scientist, Laplace, noted for his knowledge of figures, in the beginning of the nineteenth century published his Nebular Theory on the Origin of the Solar System. Soon his ideas were adopted, for they explained the birth not only of our sun and planets, but also of all star systems of the heavens. The nebulæ are solar systems, growing like our sun and planets once were before they shaped into forms they have now. Worlds, and suns, and stars, and planets are forming now before our eyes, we call them nebulæ. Let us see this theory of creation, which little modified has been accepted by all the learned.

Once all the matter of our sun and planets were in a state of gas, mist, metallic clouds, extremely thin or diffused through a space extending far beyond the farthest planet Neptune. Every system of the universe was first in this state of dust mixed with gases a thousand times thinner than air. In that thin diffused state the Almighty brought the minerals forth from nothing at His mighty word. Matter then had no form, no motion, no light, no heat, no force. This state of matter exactly agrees with the words, "And the earth was without form, and void, and darkness was upon the face of the deep." Gen. i. 2.

Matter stays where it is put. A stone, a brick, any object will stay where it is placed is till some one moves it. Thus the mountains, the soil, the materials of our buildings rest where we put them till removed by a force outside themselves. So the matters of the universe would have rested ever and forever if not moved by a superior force. Dark and motionless would these metallic vapors and gases have remained if they had not been given movement. The Hebrews had no word for gases we are describing, and the Bible called them "waters." But how did they get movement? The account continues, "And

the Spirit of God moved upon the face of the waters." Gen. i. 2.

The matter of the universe after it was made was still. It was an ocean vast and deep of metals and gases extremely thin. It had no force, no movement, no attraction or repulsion. The mighty globes of matters, now forming the heavenly bodies, stars, nebulæ, suns and planets as metallic vapors rested moveless after they came forth from nothingness—eternal night moved by the might of the Almighty. Light, heat, electricity, attraction, repulsion and gravitation, etc., are but different modes of one force we call movement. Where did this movement come from? From God, Primeval and Eternal Force. He moved matter when the "Spirit of God moved on the face of the waters." Gen. i. 2.

What was the beginning of these forces, how do they act? The original force is attraction. It makes everything in the universe heavy. But all things have not the same force, some are heavier than others. Water is heavier than air, aluminum lighter than gold, gas lighter than air, solids are denser than fluids, and the latter less dense than gases—each material has its own forces given at creation. Different materials unite under their own laws, and make the varied things we find on earth and in the stars. Among the stars weight is called universal gravitation. Every particle of matter in the universe has weight, that is, each particle attracts every other particle of matter according to the inverse ratio of the square of the distances they are apart. This alone would make the heavenly bodies all come together with one tremendous crash. But when the "Spirit of God moved over the waters," that is primeval matter, He gave each material its own force or energy to condense and sent them whirling around each other according to the laws He imposed on them, and according to this attraction they were to form orbs by lapse of ages.

Force can never be destroyed, it can only be changed into heat, light, electricity, etc. Only God Himself who

made it can destroy it, for it is an image of Him who is the eternal Force, Living Power, Origin of all in nature.

When force or movement in matter is stopped suddenly it appears as heat or light, etc. Strike a piece of iron on the anvil and you heat it, for the force of your blow is changed into heat. Coal is only light and heat of the sun ages ago stored up in planets of former geological epochs, which now burned gives out this heat and light. All force and movement on our earth came from the sun, the latter got from its Creator.

A metal having little heat is solid, heat it more and it melts, continue to heat it and you will have a metallic gas. You see this in ice, solid water, which heat melts, when it becomes water, but heated still more and it becomes steam. All materials in the universe can be changed this way by heat. Force, movement, activity, gravity, repulsion, light, heat, electricity, work, etc., are but so many different kinds of movement, and every movement in nature can be traced back to the time "the Spirit of God moved" over the dark void of formless matter filling the great expanse of heaven where are now the stars.

It took a long time for men to understand the nature of motion, force, heat, etc., and still longer before they saw that all these are different modes of the same force. But the great minds understand that all natural forces are one and the same in different forms.

Bacon in his Organum, says: "Heat itself, its essence and quiddity, is motion and nothing else." Locke wrote: "What in our sensation is heat in the object, is nothing but motion." Descartes held the same opinion. Boyle, two centuries ago, wrote a treatise called, "The Mechanical Theory of Heat and Cold." Rumford made interesting experiments, and he published them under the title, "An Inquiry Concerning the Source of Heat Excited by Friction." Father Secchi wrote a work: "The Unity of the Physical Forces" more than forty

years ago, in which he shows that light, heat, motion, electricity and all the natural forces are one and identical appearing in different forms. It was the beginning of the great development of practical electricity in all kinds of electric motors, trolleys, etc.

Mayer studied the subject in Germany, and Jule in England. The latter found the heat which would raise a pound of water 1 deg. F. would be generated by a pound weight falling 772 ft., or 772 lbs. falling 1 ft. Soon the mechanical theory of the natural forces was worked out, and became a fixed science. What is an engine but a machine to change heat into the movement which turns the wheels of our machinery?

Now let us turn these simple principles regarding energy, or motion to our subject the stars. When the meteorite shoots down into our air, its terrific motion is stopped that heats it red-hot, and even often dissipates it into vapors of the metals composing it. That law rules among the stars. When the immense masses of matter fell into the highly condensed centers by attraction, the arrested flights of the particles falling, so suddenly stopped caused intense heat. In the stars this force, suddenly stopped, shows as light and heat they still give out. In the case of the smaller masses, as earth and planets, the light and heat they once had for the most part was lost long ago. In the larger planets, as Neptune, Saturn, Uranus and Neptune, some of this heat remains, they are still in a state of metallic vapors, fiery hot. The sun and stars, which are much larger than these planets, still throw out their light and heat.

Under the influence of attraction alone all materials form round globes, as the heavenly bodies and as drops of water or any kind of matter in a fluid state. Thus the orbs of heaven are all round. But because they turn their axis similar to the earth each day, they are mostly flattened at their poles—that is, they bulge out an expanded ring round their equators. As they cool from the surface, the matter first forms a thick shell inclosing

the melted interior. The surface of our earth shows that all the deeper rocks were once melted and then cooled. But the waters of the earth, when it was hot, was a great surrounding atmosphere of steam which condensed into water and this formed great floods which ground the rocks into the soil.

From west to east the vast expanded masses of matter of our solar system moved. All the orbs move in this direction, thus they whirl round on their axis, thus the sun rotates and thus planets circle round him. But with that movement all matter was given attraction, one particle for another, according to the laws of universal weight or gravitation. The matter of which our sun and planets were later made, as a mighty globe of gas containing all the minerals and fluids and gases slowly turned on its axis with the motion the Creator, the "Spirit of God" gave it.

This great globe extended on all sides far beyond our farthest planet Neptune, 30,000 times farther from the sun than our earth. But the matter forming this globe was not all of the same density. In eight places Eternal Intelligence made it denser, and there, in these dense regions, under the laws of attraction these parts condensed into the planets Mercury, Venus, Earth, Mars, the Asteroids, Jupiter, Saturn, Uranus and Neptune. Thus Wisdom, looking far ahead, made matter in places so it would condense into the sun and planets where we see them now. Who is so foolish as to say there no Mind presided over the formation of the worlds?

As this gaseous globe condensed under laws of motion and attraction, or weight, it threw off these vast portions in dense parts, which kept their motions from west to east. These, still ruled by their weight or attraction, gathered to themselves all the thrown-off materials—under these laws grouped themselves into the planets. Anything moving will move till stopped by something outside itself, and the planets go on forever

in their orbits round the sun. They retain that movement God first gave them, for they strike nothing which would stop them.

In numerous other places matter was made in denser spots and these condensed into the meteorites, which sometimes fall into our air, and others into the sun to keep up his heat. But the number and mass of these were regulated that just enough of them might fall into the sun to keep his heat just right to light and heat our world, that living beings might not be frozen or burned up. Who could foresee this but the Divine Mind?

We said the great globe of gas contained all the matter now in our sun and planets, and that these gases and mists and clouds of dust were not the same in density in all places. For if all were of the same density beyond Neptune, it would have had hardly any cohesion, it would be so thin that in turning it would have given off only small fragments, these would have condensed into small particles, or meteoric dust, and there would be no sun or planets. For then this globe of these metallic vapors or nebulæ would have had only about the two-hundred-millionth of the density of our air at sea level, and it would be much less dense than that on its outer surface, where it would be exposed to the cold of the spaces between the stars, more than 449 degrees below zero, which would solidify hydrogen. In this cold everything would at last become solid, forming fine dust, and make one vast solid globe. But God provided for all these things so matter would form worlds and suns.

Simple were the laws the Creator imposed on matter which broke up into the worlds. These laws still rule the universe. Everything has weight; if not held up it falls towards the center of the earth, planet, or sun. So the matter of this tremendous metallic gaseous globe with weight condensed towards the center where is now our sun. This weight, called universal gravitation, is a force or movement which came from the Spirit of God when He moved over the waters, when He gave mat-

ter motion going round. Everything attracts every other thing, according to the law of gravitation, and this weight is found through the universe. Obeying this law all the materials of which our sun and planets are made tend to and condense towards the center. Thus the mighty globe of diffused matter became smaller and smaller.

The smaller it became the faster it turned—that is a law of whirling bodies. When you set a wheel in motion and turn it faster and faster a time comes when the movement becomes so fast the wheel bursts, smashes to pieces, and these pieces fly away with great force. The fragments flying away turn on their axis more or less rapidly before they strike any object which stops their flight. Often people are injured or killed by bursting wheels.

So the whirling, cosmic globe condensing, turning faster, a time came when it threw off from its surface great masses of whirling matter. This law has been studied by learned men in cases where one heavenly body comes near another, and the point when one of the bodies will be torn asunder is called the "Roche limit." Not only a globe of gases, metals ground to powder, will be torn asunder, but even a solid globe. In a certain way we see this in the tides raised by the attraction of the sun and moon, which if nearer to us would tear the waters of the ocean from the earth.

According to this law every planet, or rather the matters in them, were thrown off from this circling globe of diffused matter as they condensed towards the center. Projected from its surface each went whirling on its way, and thus the materials of the planets were thrown off and they still turn on their axis with a slow motion. But they were held in their orbits by the greater attraction of the vast central mass. The matter of the planets obeyed the laws of condensation, got smaller and smaller, turned faster and faster, till condensed into the heavenly bodies we call the planets. As they condensed, follow-

ing the law, they also sent forth other masses from their surfaces, and these became the moon or satellites revolving round the planets.

Thus by simple laws, when God created, as mists and clouds, the Spirit of God made matter, revolve with the movement impressed on it, and under this movement the worlds, the sun and planets and moons of our system were shaped and formed and placed in the heavens where we now find them. We are astonished at the simplicity of the laws God gave matter, which brought into being the heavenly bodies of our solar system. Still more astonished we are to see thousands and thousands of gaseous globes—nebulæ, in all parts of the heavens obeying these same laws are now forming worlds and suns and planets.

Learned men study laws ruling matter in the form of a great globe of gases, clouds, mists, oil in water, etc., matter turning around as we described, and we give the results. As the tremendous globe of our solar system slowly turned, it still more condensed under attraction, that took place round the places where the matter was the densest, round the center where is the sun, and round the materials now composing the planets. Tie anything to a string and swing it round so the string will wind round your finger, and the shorter the string becomes the faster it will whirl, till at last all the string winds round, and the object strikes your finger. The object tries to fly away, but the string holds it.

Let your finger represent the great central sun mass in this turning globe of matter in a state of gas and mist, the string universal gravitation, and the effort to fly away the repulsive force. The first is the sun, the second is universal gravitation, and the last the repulsion of the turning globe.

Now let us apply these attractions and repulsions to our nebula of matter turning round. The more it condensed the faster it turned, and more it tended to throw off the outer parts. A time came when the repulsion

became greater than the attraction and it threw off at the outer edge a great mass of condensed matter at a place about 30,000 times farther from the center than our earth is from the sun. This matter thus projected still had its movement round its own central mass. When it was torn off it took a motion round itself, which we now see in the planet into which it condensed, Neptune, 2,745,998,000 miles from the sun. Neptune goes round the sun in about 164 years, and we conclude that our great globe turned round on its axis a little slower than this when it drove out Neptune's materials.

Faster turned the globe of matter as it condensed under gravitation, for that is a law of mechanics. A time came when the tendency to fly off overcame attraction. When the surface of the misty globe was about 1,753,868,000 miles from the center, a great mass of materials was thrown off and condensed into the planet Uranus, which goes round the sun in a little more than eighty-four years.

Smaller still became the whirling globe of matter, mist and gases, when the outer surface was about 872,137,000 miles from the center, a great quantity of materials was hurled forth, which condensed into the planet Saturn, revolving round the sun in 29 1-2 years. Smaller it became, still smaller, till when the outside was somewhere about 475,692 miles from the middle, the whirling motion getting always faster, a mighty quantity of matter was thrown out which condensed into the planet Jupiter, which revolves round the sun in nearly twelve years.

Smaller still became the matter of our nebulæ under these laws of movements till it condensed so the outer surface was somewhere about 139,311,000 miles from the center. As the smaller it became the faster it turned, it then projected a lot of matter which condensed into the planet Mars, which revolves round the sun a little more than 686 days.

Still condensing—becoming smaller and revolving more

rapidly, at about the time when its surface was 93,000,000 miles from the center, the globe threw off the matter which condensed and became our earth with its satellite the moon, which revolves round the sun in 365 days.

Leaving our earth to follow its motion, the matter became smaller, and when its diameter condensed to about 66,134,000 miles from the center, the whirling force projected the materials which became the planet Venus, which revolves round the sun in 224 days.

Gravitation still more condensed the gaseous, misty matter, and faster it revolved under the law we have given, till at the distance of about 35,392,000 the rapid whirling globe threw off the materials of Mercury, which travels round the sun in about three months.

Still the central matter contiued to condense and revolve faster till the great central mass became our sun, which rotates round its axis in about 25 days.

Can we give the distances from our sun the central mass where the planets were projected? Take the distance from our earth to the sun and call it 1,000, and we find Mercury is 387, Venus 723, Earth 1,000, Mars 1,524, Jupiter, 5,203, Saturn 9,539, Uranus 19,183, and Neptune 30,037. There is a certain uniformity in these distances called the Bode or Titius' law of the distances of the planets. In regular order one planet is double the distance of the planet within. Mercury 0, Venus 3, Earth 6, Mars 12, Asteroids 20, Jupiter 24, Saturn 48, Saturn 96, Uranus 192, Neptune 384. These figures give the relation of their distances, showing a Mathematician presided over the movements which projected the planets into space, for their distances from the sun form a geometrical progression.

But the amount of matter created which was to form the planets does not follow this law. For there was to be one planet, Earth, the habitation of man, and this was in the Almighty Mind when the worlds were made. If we take the mass composing the sun as 315,000,000, that of Mercury will be 65, Venus 885, Earth 1,012,

Mars 118, Jupiter 300,860, Saturn 69,692, Uranus 12,650, Neptune 16,773. By this it is seen that the earth, including the moon, in mass is much larger than the two planets within and without us—Venus and Mars. If the planet masses had been in proportion, as are the distances, we could not live on earth. The attraction would be so small all things would weigh so little they would not hold together.

Take a fluid gobe, as oil in water, such as we suppose the melted earth was in when in process of formation, the mass of the moon being a part of it. Make this oil turn round as the then earth did, as it floated round the sun. As you increase the rotation the oil takes the form of an egg. Make it turn faster as the earth's rotation increased when it cooled and became smaller. The oil becomes a long round mass like a soft egg squeezed to make it longer. Keep increasing its rotation perpendicular to its longer axis, and a time will come when it will throw out or separate from the two ends, which will form two round bodies of oil. Then the parent mass of oil becomes round again.

Here you have not one, but three, round masses of oil. This explains how the moon was thrown from the earth. But why were not two moons in place of one projected from the fluid earth? We do not know. A Force above matter directed only one moon formed. Some say two masses were thrown out and these united to form the moon. Professors Darwin and Jeans took up this question, followed the motions of worlds thus forming, followed out the movements, through the higher mathematics and came to the conclusion that the nebula theory has many defects. They admit matter alone following its laws will not produce planets, that another Force must step in to form the worlds, and this Force must have Mind and Intelligence to direct matter.

The moon's mass is 1.80th that of the earth, whereas Titian's mass, Saturn's largest satellite, has only 1.4600 of Saturn's mass. Why was not the same proportion

of matter one-eightieth as between earth and moon thrown out from Saturn to form his satellites, and the same proportions between the other planets when their satellites were formed? We do not know. We can only say a Supreme Power, not bound by nature's laws, presided over the formation of the worlds.

The friction of the tides caused a loss of motion; the tides cause the earth to loose only about a second of time in a century. We can imagine how long it took to form the moon, place it where it now shines, 240,000 miles away, and make it circulate round the earth in about 29 days. For when the moon was born of earth, it had a revolution like the latter, which now rotates in 24 hours.

Professor Darwin says: "Our ideas are absolutely blank as to the time required for the moon's evolution either according to Laplace's nebular hypothesis, or the meteoric theory. All we can say is, that they demand enormous intervals of time as estimated in years." If it took so long for the moon to separate from the earth and get so far away, 240,000 miles, where we find it now at the rate of a second in a century, which the earth loses through the tide action, we will have to estimate the numbers of seconds in 29 days of the moon's revolution, multiply this by 100 years, then multiply this by 240,000 miles, the distance of our satellite. The result is so enormous the reader can hardly realize the number of years. But the sun, losing light and heat, long ago would have become a dark sun before the moon would have got so far away. Mathematics therefore prove that another Power presided over the formation of the moon in addition to the natural forces.

CHAPTER VI.—ARTURUS, ROUND WHICH OUR SUN AND EARTH REVOLVE.

No heavenly body is at rest. If it did not move through space the attraction of a star would drag it down and they would come together with tremendous force. Once we thought our world was still, we supposed our sun was still, remained ever in the same place; but he, too, is moving through heavenly spaces. Otherwise he would fall into another sun, dragging with him his train of planets. The collision would disrupt and grind the sun, planets, and the world to finest dust, and turn to metallic vapor every material of earth because of the awful heat the stroke would cause.

The millions of suns are ever in motion with the movement the Creator gave them at their creation. If they stood still in space they would all finally fall together into one mighty globe of matter of awful heat and light. They follow mathematical motions through space. They were hung on figures when the Almighty "Spirit of God moved over the waters." Gen. i. 2. The Spirit therefore is the Source and original Mover of the universe.

Sir Wm. Herschel first noticed stars in one part of the heavens spreading out, separating from each other, and the stars in the opposite regions drawing nearer to each other. He spent years of labor studying these changes, and concluded our sun and solar system is moving towards a point in the constellation Hercules. The astronomers who followed him took up the question and agreed we are flying towards the outstretched arm of Hercules. Professor Newcomb, of Washington, thinks we are going towards a point south of the brilliant star

Vega. Measurements of star-movements down to 1900 give our flight as 15 miles a second, while Professor Campbell, with the spectroscope, figured it out as 12 1-2 miles a second. It is astonishing how nearly alike these measurements are, differing only 2 1-2 miles. According to the last figure, which is perhaps about correct, we are traveling at the rate of 1,036,800 miles a day, flying through space with our sun and planets, 378,432,000 miles each year. This is a short distance in the vast expanses between the stars, for at this rate it would take us 68,000 years to arrive at the nearest fixed star.

Astronomers do not agree as to the point we are approaching—some think we are going towards Vega, not Arcturus, that it will take us 558,000 years to pass Vega, and that we will not revolve round Arcturus. For, as all the stars are moving, this mighty orb will not be in the same place when we arrive there. The parallax of Arcturus gives its distance so great, its light is 160 years on its journey before arriving at our earth. That would require about 2,500,000 years for us to reach him at the rate of 12 miles a second. Professors Struve, Newcomb and other astronomers, following Herschel's figures, locate the point towards which we are going in the constellation Hercules. The learned do not agree, and we must wait for further discoveries. In the meantime we will give the theory of Arcturus held by the learned. But this is not positive, although it may interest the reader.

We are in the middle of the great wheel of the Milky Way, near the center of the three concentric globes of stars we see as constellations spread over the heavens. Down from time immemorial came a tradition that man is in in the middle of the universe, made for him, sole reasoning being of earth. The discoveries of Galileo and his disciples seemed to disturb our central position, and placed the world as one of the planets with the orb of day as the center of the solar system. That

seemed to upset the ancient tradition, to contradict religion, and much disturbance followed. But later discoveries prove we are in the middle of a far greater universe, than of the solar system of sun and planets. For millions and millions of suns are round us, pouring down on earth their light, heat and forces. Thus modern science has restored man to his central position as the primeval object of all creation. Religion and science always are in harmony when we know both well.

What star is the very center of the universe? In far-off days poets sung of a sun, greatest of the orbs of God. Job says: "Who maketh Arcturus and Orion and the Pleiades and the inner parts of the south." Job lx. 9. From remotest times a legend came down that Arcturus, then called Atlas, upheld the world, and that the Pleiades were his daughters.

The Great Bear is known to every one. The ancients called it Septem triones, "The Seven Oxen," whence the word Septentrionalis, the ancient Latin name for North. The Arabs named it Aldebb al akbar; the Chinese, Tcheou-pey, "The North god." Forever circle the stars of the Great and Little Bears round the north polar-star. Down below them, but above the Virgin, is the constellation of the Bootes, composed of 54 stars. Bootes was the fabled son of Jupiter and Callisto, called also Atlas, who carried the world, because his head was near the pole. As when he sets the Pleiades also set, it was supposed the latter were his daughters. Not far away shines, like golden rain, Berenice's Hair. They had queer ways of naming constellations. In the year 246 B.C., Queen Berenice made a vow to cut off her hair and consecrate it to the gods in Venus' temple, if her husband returned victorious from battle. The hair was stolen the following night; her husband was much displeased, till the astronomer Conon assured him the hair had been transported to heaven by Venus' orders, and shone as a constellation.

Below the constellation of the Northern Crown, below

and at the left of the Great Bear, you find a constellation the Greeks called the Bootes, "an ox," which they imagined was shaped like an ox-driver. Hercules stands with a club in his right hand, in his left a leash with which he holds two hunting-dogs. The Great Bear's tail extends down till it covers his belt, in which you see with naked eye a star of the first magnitude, they named *Arctos,* "a bear," and *oura,* "a tail," whence the name Arcturus, "the bear's tail."

A little lower and to the left of the polar star, you will see Sirius, called the "Dog Star," brightest of all the fixed stars. It is in the constellation called the Great Dog. Its light is red, and the ancients called it "the red star." Seneca said it was as red as Mars. Enveloped with deep, fiery metallic gases and layers of hydrogen, it is going away from us at the rate of about 20 miles a second, and athwart the line of sight at the rate of 15 miles a second. Huggins estimated its movement at 33 miles a second. It has a dark companion nearly as large, and they gyrate round each other.

Two nearby stars seen as one body circle round a common centre are bright. The bright body is 13 times as large as our sun, but not large enough to attract our sun to circle round it, because of its great distance from us. For it is 50 trillion miles away, and it takes its light 8 years to reach us. Canopus, a star of the first magnitude in Argo Navis, 37° from the south pole, round which it seems to circle, is the next brightest star. Vega, in the Lyra, and Rigel in Orion are all suns many times larger and brighter than ours, but they are too far away to rule our system. Vega with its immense weight and mass only swings our sun and planets round in parabolic perturbations.

God made a sun large enough, Arcturus, round which swings our whole solar system, as our earth rolls round the sun each year. It is in the constellation of Hercules —not far from, but below the Great Bear, in that constellation later called the Bootes, in the border of Her-

cules' robe, in Lat. 20°, near Long. 20°. In size it is almost 1,000 times larger than our sun, the diameter of which is 853,000 miles. Vega is only 100 times larger than the sun. The diameter of Arcturus is said to be nearly 853,000,000 miles. When we think it is 93 millions of miles from here to the sun, how will we get any idea of the size of this gigantic body 927 times larger? The human mind has hardly power to grasp these figures. Yet this sun God made this size to hold our sun, earth and planets that they may circle round this mighty star lest they fall into another heavenly body under the laws of attraction, and we perish.

At the Yerks Observatory they took photos of Arcturus' spectrum. There are few really dark lines, but 14 partly shaded and different colored bands. Hundreds of bright lines look like little bright columns insensibly merging into each other. They are crowded together so they touch. Arcturus' spectrum differs from that of any other star in its surpassing brightness, in the width and number of its lines, and in the way they crowd together. Compared with the spectrum of titanium, the 46 lines of that rare metal are seen in Arcturus' spectrum, but in this mighty sun they are bright in place of being dark, as they are seen in the spectra of some other stars. Eta, in the constellation of the Lion, shows those titanium lines, but they are dark, as in E of the Great Dog, and are separated by bright lines. B of Orion gives the lines of iron and vanadium as taken at the Flag Staff Observatory in Arizona.

The observations of Arcturus through the spectroscope show it to be the hottest sun in heaven. The metals on its surface are in a state so hot as to be seemingly beyond a gas, in some mysterious state or condition of matter we do not yet understand. The lines are more like those given by vapors and gases in an extreme diffusion at a heat beyond our imagination. This heat was caused by the great amount of matter which fell into the mighty

sun and raised its temperature much higher than that of any other orb.

When we discovered the path of our sun round Arcturus, we found a truth of highest importance. Our solar system follows a parabolic curve like the tracks of a railroad—curving at one end round a sun, the path being a parabola similar to the paths of the comets round the sun. This, the first discovered track of one sun sweeping round another sun, shows us that the millions of suns follow these elongated curves of conic sections in circling round each other. The shining orbs come from depths of space like comets entering our solar system, and these suns sweep along these vast paths, rush towards each other, the smaller circling round the larger suns and then swing back the other side of their course billions of miles, distances almost countless, taking million of billions of years to complete their journeys. Thus the hundred millions of suns forever and ever sweep round the heavens.

Comets come from far-off spaces, swing down into our solar system, approach so near as almost to touch the sun's surface, swing round his fiery mass, tail, nucleus and all materials heated to an incredible degree, and then pass out among the star depths, some to come back on other visits, others to be lost in star deeps.

Thus our sun, leading his court of planets, follows a parabolic path down from near the Polar star as it sweeps south towards Arcturus. When ages will have passed our earth and sun will approach this Arcturus, tremendous in size. We will plunge down near his surface; his heat will melt our world, destroying with his fire all that lives. How utterly helpless we are to prevent this catastrophe! We can absolutely do nothing but meet our fate. As was revealed to Job, so it has been handed down the world would be destroyed by fire.

Richard H. Byrd says: "Our sun through the centuries trails a long ellipse, dragging the world of course with it, and just within one end of this ellipse blaze the

rays of another sun, known to astronomers as the star Arcturus. At the other end of our sun's ellipse are cold voids, vast spaces of absolute zero.

"Astronomical records are complete enough to show that somewhere more than twenty centuries ago, Arcturus was visible only as a luminous speck. Now it blazes in the evening sky, bright as the planet Jupiter, a beacon among the glittering points of fire that stud the firmament this side the Milky Way. Manifestly our own solar system is approaching the sun Arcturus.

"The rate of travel of our sun through space, carrying with it its little group of satellites, including our world, has been determined with fair accuracy. We are racing southward through the heavens at the rate some say of about 5,000,000 miles a year, along an arch whose segment shows undeviating progress in the direction of Arcturus. Eventually we will be carried clear round this star, and be subject to its fierce rays, then we will come back on the other side of the ellipse, and will be carried along a wide and awful sweep towards the Polar star, now in our rear, and to the extreme curve, which must be passed before the journey back again begins. How many times our solar system has swung that almost illimitable course none can ever know or guess. But in this great course there are just two extremes of seasons, except that instead of their being six months they are about 75,000 years apart. The summer season of this vast cycle is unutterable heat—the melting point; the winter season, frigidity. That we are now a little more than half-way down the journey to the summer turning point, and entering on a spring-like opening to a young summer of celestial weather, is made clear by those whose study is the sky, and to whom the stars present but partial mystery.

"The astronomer Leroy Tobey has shown that the course we are traveling is regulated by the influence of Arcturus, and that it will carry us around that torrid star in something more than 25,000 years. The turn

will bring us so near to it, and into the zone of heat so high, that physical life in its present form will be impossible, for Arcturus is an incandescent sun, known to be vastly larger than our own. The belief that the world shall die enwrapped in fire is true, as all beliefs are when they are understood.

"On the other hand, at the Polaris end of the great ellipse are "thrilling regions of thick-ribbed ice." Flung to the extreme limit of its course, before it turns again in answer to the magnet of its orbit, our sun and the worlds that encircle it, being farthest from their source of heat, will dim and fall into a sleep of cold, so deep that life will be suspended."

Professor Leroy Tobey figured out the flight of our sun with his planets swinging round Arcturus, and we give his theory for what it is worth. He says we are going along 84,000 miles an hour, and that it will take 104,000 years to make the revolution. We are now approaching the nearest point in our orbit to this mighty sun. Our path is not an exact circle, but a long parabolic ellipse, or oval, similar to the paths of the comets round the sun. As we are getting nearer to Arcturus, we begin to feel his heat—so mild it is hardly yet felt, but it will become greater as we get nearer.

There was a time when the earth had a different climate, when it was covered even to the poles with great forests and plants which got covered up and became coal. Then came a change to colder weather. The waters round the poles froze, and the different ice-caps at different epochs came down from the poles towards the equator. Plants and animals of these geological epochs died with the cold. We find their remains in rocks, earths and coal formations. They are strewn round the poles and in nearby regions, where they now could not live. Then came another change. The weather got warmer, the ice-caps melted, and the lands round north and south poles rejoiced in milder climate. The climate after the last glacial period gradually became more

balmy, and at last man appeared. Since the beginning of historic days, the climate has been changing. Even now the winters are getting milder, the summers cooler, the glaciers are receding. This ice-cap and why it disappeared excited the curiosity of scientists. Our approach to Arcturus with his great heat explains the change. It is warmer when we are near him and colder when we are farther away from him.

Our earth in its relation to this mighty sun, Arcturus, March 21, 1905, entered on another glorious spring that will continue for 18,000 years, during which we will approach this tremendous globe of fire. His light and heat will become brighter as ages pass. No change will be seen by any man with unaided eye during his lifetime. But future astronomers will see Arcturus change from a star of the first magnitude to the brightness of Venus. It will at last become so bright as to be seen during daylight, and at length so bright it will become that it will cast a shadow. As our sun with his planets swings round this sun awful in size, the climate will become still warmer. The earth will enter its summer of 18,000 years on June 21, 19,905 years after Christ. Then Arcturus will appear almost as large as the sun, its light will be much brighter than that of the moon. Then we will need no lights in our streets or houses, for Arcturus' splendors will take their places.

During the days of this hottest summer, the midsummer day being August 8, 28,000 years after Christ, will Arcturus' heat burn up the world and destroy all life on our earth? Will the dazzling light, the terrific heat, the invisible rays render our earth unfit for inhabitants? Plants and animals survived former Arcturus summers and will again. On December 22, 55,905, A.D., our sun and earth will be on the opposite side of Arcturus, just entering on its winter when the long, cold, arctic winter will begin to bind every drop of water round the poles into another great ice-cap, such as we have described and which geologists show once covered the northern and

southern parts of the world. For over fifty thousand years this winter will rage, and at its end our world will again enter on another spring such as we are now beginning.

A thousand things show we are entering on a warmer season, the great spring-time of our earth. The winters are getting warmer, the summers cooler—we can see the changes during a lifetime. The glaciers on mountain-tops, and along the valleys of arctic regions, remains of the ice-caps round the poles are getting smaller every year. We find rocks, boulders, sands and gravels along the ground left by the ice-fields which once came down from the north and south poles, over the surface of the earth. We see marks and scratches made on mountain, hill, and dale by the rocks frozen into the covering ice as it was pushed along. We see the sand and gravel ground fine by freezing and thawing. We find the soil torn from mountains, hills and plains of the far north pushed down and formed into the soil in which plants grow to sustain life. The ground and soil could not have been better prepared for living beings than by the tremendous force of the ice in these far distant epochs, perhaps millions of years before Adam was made. And that Providence which thus shaped the world for man, foresaw and provided for all the wants of our race as long as human beings live on the surface of our planet.

Many kinds of animals once lived on our globe long before man appeared. We find their remains all over the earth, both north and south, scattered almost to the poles. Their structure, mode of living, instincts, food, etc., show that they lived in warm, balmy climates different from what we to-day find in these cold regions. They lived in days when Arcturus' heat and light made countries now covered with frost and snow suitable for them. What killed them? When the world entered on its great long winter as it receded from Arcturus, the cold killed them and the ice-cap buried them.

There is hope for our race, says Professor Tobey. For

in making this great winter journey away from Arcturus, the sun will draw near some of the other great suns, and from them receive enough light and heat to sustain life on our planet. Still the figures regarding our path round this mighty star, if better worked out, may show we will not come as near Arcturus as we thought, and life will not be destroyed with his heat. Before giving a final opinion, we must wait for more and better observations, and calculations of our orbit round the mighty sun. However may end our race we know the Creator made these millions of suns and stars for us, placed them in the heavens, gave them His laws and their movements, that they might serve us. We may possess our souls in peace, all which will come to pass will be for our good. We will rest assured His Providence foresees and provides for mankind.

CHAPTER VII.—THE SUN AND HIS TREMENDOUS FORCES.

The sun, center of the solar system, that group of planets to which our earth belongs, holds these worlds in grasp of attraction, because his mighty mass is so great compared to all of them combined. Round him they go whirling on and ever, each planet like a part of a mighty wheel, weight taking the place of a spoke, gyrating with movement and impulses the Creator gave them. Two forces so balance they do not fall into the sun or fly away.

Down to earth the sun is ever sending heat, light, electric impulses, rays invisible for chemical and physical actions of plant, animal and human life. There is not a movement of raindrop, flowing stream, machinery, or of life we do not trace back to the sun as to their origin. These forces in the sun are the remains of energy, he received from matters falling into him since creation. Thus all activity in the universe came originally from the Almghty Force infinite we call God.

From days of old men untold traced nature's movements to the sun. In Babylonia they called him San, "the holy," whence our word sun. He was to them an image of Il, in Hebrew El, "the Mighty One," and gate was *bab,* whence they built Babylon, "Gate of the Mighty One." In Egypt the sun was Ra, whence Pharaoh was supposed to be "Born of the Sun God," a tradition of Adam God made of earth. Still the Brahmins of India worship the sun. "What race do I belong to?" said a high caste Brahmin to the writer. "I also, like you, belong to the Arian, 'the noble race,' but I am black because of the climate. Certainly we adore the sun. He is the Worker of God. Without him nothing

would live. There are three Eternals—God, Life, Matter. These Three are One."

The reader may ask: How do scientific men get their measurements of orbs? By direct and indirect measurements, and the first is proved by the latter. We measure minute changes of heat by an electric current passing through platinum, small movements by interference of colored light rings, and gravity by pendulum beats. Colors of soap bubbles, electric actions between zinc and copper, camphor on water, give measurements down to millionths of an inch.

Astronomers measure angular distances by graduated circles, by micrometers in the eye-piece, or by photographs. The time of the passage of a star thousands of times will show if it changed its position to right or left, the spectroscope lines tell if it is coming towards or going from us, the thermopile or bolometer show its heat, triangulation its distance, and these will give its size.

We first find the exact diameter of the earth, which serves as our base-line for triangulation, then we measure the angles the heavenly body makes six months after the first observation, when the earth is 185,800,000 miles away on the other side of its orbit. Kepler's third law gives the proportions of distances of the planets from the sun when their times of revolution round him are known. The passage of a planet across the sun gives measurements we call its parallax. Expeditions were sent out by governments to distant countries to observe the transits of Venus in 1761, 1769, 1874 and 1882, from which the distance of the sun was measured. The parallax of Mars, or of one of the outer planets, is computed by measuring its angular distance from one of the neighboring stars.

By mathematical deductions from the law of gravitation a formula is obtained which gives the elements of the planet's orbit, and determined relations to the parallax of the sun, moon, and other planets. The movement of the earth in its orbit round the sun, combined

with the motion of light coming from a star, causes aberration of the light, by which the star appears thrown forward from its true position in the direction in which the earth is moving. This change in the light's direction differs according to the earth's movement regarding this star, and is measured at different seasons. We know from experiments on earth the velocity of light and thus we can measure earth and star movements.

We measure the mass of the earth by the deflection of a plumb-line by a mountain, by change of weight in deep wells and on high mountains from that of the surface. Knowing the weight of the earth and its velocity round the sun once a year, and the distance of the sun, we can tell the amount of matter in the sun even to a ton. For just that weight must be in the sun to keep the earth from flying away or falling into his fiery surface. Following the same principle the mass or weight of a planet and of its satellites is measured by the perturbations it causes on other planets when they come near. But when we know the weight of the sun we can also figure out the weight of every planet by the time it takes to complete its orbit round the sun.

You find a small arc of their paths, and you can tell the velocity of their flight, their weight, and even density and distance of suns are unfolded before you. You can tell to the exact second an eclipse of the sun, of the moon, of Saturn's or Jupiter's satellites. You know the motions of every planet, our sun and many of the other suns, because you figure out their mathematical movements. But who was the Mathematician who gave them these motions and these laws founded on figures? All is in motion according to higher mathematics. Who is this awful unthinkable Wisdom who gave these movements according to the higher mathematics? In what school or university did he learn the sciences?

When learned men therefore figure out the weight of sun or planet, they find that learned Mind was there before them, who from creation laid down these figures,

weighed the suns and stars, and placed them in their orbits, and gave them exact movements or forces so they will go round forever. We study arithmetic at school, we learn square root, and cubic root. We go into the higher studies—algebra, and calculus, and logarithms, and conic sections, and such studies as are taught in universities. These we apply to the stars and to the sciences. As far as man has penetrated into the secrets of nature, he finds that he is only going over the foot-prints of a Supreme Mathematician, who built the universe on these higher figures. Matter itself did not give itself these wonderful laws, for a stone cannot think. We did not do it. The laws are there. The universe was not always, for it has changed, it is always changing, and that which changes cannot be eternal. For if the universe were always, long ago it would have lost all its light and heat.

In laying before you, in the preceding chapters, the discoveries regarding the stars, we said little relating to the tremendous fires and forces of the 500 millions of orbs—stars blinking and winking at us, seeming to call us to a better study and understanding of their wonders. How oft people ask what are the stars? Science replies they are suns. When we study our own sun, its materials, size, constitution, the whole domain of solar physics, we better understand the constitution of the stars.

Let us first see how far away the sun is. On earth we use inches, feet, and miles to measure distances. But as the distance from earth to sun is the yard-stick of the heavens, we must first get a correct gigantic tape-line measure before we apply it to the stars. That is, we must first know the exact distance from here to the sun.

Two thousand years ago Hipparchus tried to measure his distance with his crude instruments, and concluded he was 650 times the earth's diameter. But in those days, they thought the world much smaller than it is; even ages after, Columbus supposed he touched the shores

of India and called the natives Indians, a name they still bear.

Kepler's laws upset the errors of eighteen centuries regarding the sun's distance. A little later Lacaille figured from the observations of Mars the distance to the sun as 90,000,000 miles. Leverrier, who with Adams discovered Neptune by mathematics, before it was seen by human eye, published the same figures. Saturn's satellite, Juno, was studied by Gill and others in 1874; ten years they figured on Venus transits; in 1898 Eros was first seen, its motions observed, the velocity of light determined; they covered many miles of paper with figures, till at last God's mysteries were sifted from fathomless nature reluctant to unfold this secret of the Almighty. Here we lay before our readers the results of these centuries of studies of mankind's ablest mathematicians.

Observations of planet Victoria by Sir David Gill..	92.874.000
" " " Eros, Oxford University...	92.935.000
" " " Eros, Lick Observatory.....	93.000.000
Physical Method of Profs. Newcomb & Chandler..	92.791.000
Gravitational Method, Prof. Newcomb.....	92.900.000
	5)464.500.000
Distance of the sun from the earth in miles.....	92.900.000

Remember, the earth does not follow a round ring in its revolution, but an ellipse, and it is nearer the sun in winter than in summer. Early in January we are only 91,300,000 miles away, but in the beginning of July we are 94,500,000 miles away. It is summer here although we are farther away, because the north side of the earth then turns towards the sun.

When we know the sun's distance, it is easy to survey or measure its surface. The sun is 853,000 miles in diameter. It is not solid like earth, but composed of metals in a state of gas, because of the intense heat. Its density is a fourth that of earth, and one and a half times that of water. A million and a half times greater than earth, seven hundred times larger than all the planets

together, the sun holds all the planets in his mighty grasp of weight, because of his mighty mass. As a monarch surrounded by his satellites, the sun floats in space round the mightier Arcturus. They follow him, their king, as he journeys—all subject to the laws laid down, and pursue the end marked out by the great Architect of the Universe from far-off days of creation.

The ratio of the sun's diameter to that of the earth is 109.3; that is, the sun in diameter is that times greater than the diameter of the earth. The sun's surface is 11,940 times greater than the earth's surface and contains 1,305,000 times more matter than our world. Because of his mass of materials, on the sun a pound would weigh twenty-six and a half pounds. While all discoveries show the sun formed of metals in a state of gas, yet they are so compressed by gravitation they act more like liquids. "He hath set his tabernacle in the sun," said the royal seer of Israel. It is the nearest of the orbs shining with their own light, and in the sun we can see God's mighty forces in action.

Father Secchi devoted his whole life to the study of the sun in the Papal Observatory, Rome. Years ago the writer sent for his three volumes "On the Sun," and after reading them presented them to the Dudley Observatory. There in his books will be found the wonders of solar physics and descriptions of the tremendous forces of which we can hardly form a thought.

Light and heat are the most important forces the sun sends to us. Proctor figured that each square inch of the sun's surface gives out as much light as 25 electric arc-lights. Professor Langley, by careful experiments, shows that the sun is 5,300 times brighter, and 87 times hotter than the white-hot metal of a Bessemer converter in which we make steel. Father Secchi estimates its surface heat equals 10,000,000 degrees. But only the very smallest, we might say the billionth, part of that light and heat fall on our earth, which occupies such a small part of the vast space of the imaginary sphere in which

our earth revolves. The heat of the sun falling on a surface three feet square of our earth would run a three-horse-power engine. Find how many square yards on the surface of our planet, and you will see how many such engines the sun would keep going. Find how many such square yards in the vast globe all round the sun at his distance from us, 92,900,000 miles on all sides from the sun, and you have an idea of the heat-power the sun gives out all the time. How awful is the waste of power! you say, and how little of it is caught by our earth! The rest is all sent out into the depths of space between the stars. All the rest of the light and heat, except what falls on earth, to us is lost. Almighty is our God, and He does all this, sustains the light and heat of the sun for the little part which lights and heats our earth.

Do we understand the size of this fiery globe? It is 853,000 miles in diameter. If the earth, with its moon, 240,000 miles away, were in the sun's center, there would be room for another moon 185,000 miles beyond our satellite. Another moon could swing round in its orbit just inside the surface of the sun. Eight planets—Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune, with 500 little planets between Mars and Jupiter, circle round our sun, kept in their paths by his attraction.

Why is the sun so bright? You say because it is so hot. But all metals with the same heat do not give out the same light. Burning alcohol, although intensely hot, gives little light, and it is the same with many other materials. But there is one material spread throughout the universe, which, when heated gives out a brilliant light. That is carbon we find in burning coal, wood, etc., which gives out the light we see when they burn. Carbon uniting with oxygen becomes very hot, and lights and warms our homes. In the electric light, called the incandescent, all the air has been pumped out of the glass bulb, and no oxygen is in the bulb to unite with

the carbon film, and so it burns for about 1,000 hours before it breaks.

The sun is made of gases and metals in a state of gas. The heaviest metals range down from the surface to the center according to their weight. Carbon gas is very light. A vast sea of carbon gas surrounds the sun, extending on all sides thousands of miles thick. This fiery carbon, glowing with millions of degrees of heat, sends out sunlight to the spaces between the stars which falls on the planets. If carbon were not on the sun, or if it were not so light in weight, it would sink down deep; the sun would give out little light, and we would live in everlasting darkness. For the purpose of giving out this light our God gave it little weight, but great brightness, that it might light the worlds.

This carbon in a state of intense heat forming the surface of the sun, is called the photosphere. Vast waves, thousands of miles wide and high, sweep over his surface, showing different degrees of light. Often brilliant portions and patches, called faculæ, bridge the mighty waves of gases—ever moving, changing, sweeping on in tremendous cyclones day by day, from hour to hour, like a vast fiery ocean. Powers sport on the surface of the sun of which we can have hardly a conception. During an eclipse, we see tremendous streams of fire, oft greater than our whole earth, shoot up 100,000 miles, spread out like a pine tree, similar to what Pliny said he saw on a small scale shoot out of Vesuvius when Pompeii was destroyed. But the forces playing on the sun are on such a colossal scale that the ordinary reader can have but a faint idea of them. The light from the highest matter thrown out by the awful eruptions passing through the spectroscope shows them to be hydrogen, one of the lightest gases known.

With a smoked glass sometimes you see dark spots on the surface mostly near the equator. Many years Father Secchi devoted to their study, and He found them deep depressions where the glowing carbon has been swept

aside exposing the darker but hotter materials beneath. The spots send up great whirlwinds of fire, some hundreds of thousands of miles high. Sir Wm. Herschel saw one spot in 1779, with a diameter of more than 50,000 miles. Their depth has not been exactly measured, but it is about the same as their diameter. While sun-spots last, great electric disturbances and violent storms disturb our atmosphere, showing the sun to be sending out vast impulses of electricity as well as light and heat.

The sun sends out not only light and heat but electricity to the planets forming his court, and to the other heavenly orbs. The millions of suns we call the fixed stars are also sources of tremendous streams of electricity sent into spaces between the stars. This energy, unseen and unnoticed, falls all the time on earth. It is a force or rather a modification of energy, like light, heat, and attraction—the result of the original condensation of matter created as mist falling together under attraction, building suns.

Attraction acts "inversely as the square of the distance"; that is, the nearer the bodies, the more they attract, and the farther away they are from each other the less they pull each other. But this is not the law of electricity passing, sweeping between the orbs through the spaces between the stars. For when we pass a current of electricity through a gas between two plates, "the greater the distance between the plates, the larger the current will be which passes through the gas, while the smaller will be the flow if we use metals to conduct it."

Not since Newton published his Principia, proving universal attraction, has such an important discovery been made as this by Professor Thomson (Lord Kelvin). While light, heat, gravity and magnetism passing through space diminish according to the square of the distance, electricity increases as the distance increases whether it be millions or billions of miles across the spaces filled with ether between the stars. Electricity therefore pre-

sided over the formation of worlds, and now comes from sun to earth in tremendous streams of energy. From sun to sun this mysterious form of force flows, increasing as it passes through the awful spaces dividing the stars. Therefore, with light, weight, heat, and electricity the suns are all united in one universe as they are one in the nature of their materials.

From sun and star therefore this electricity is poured out all over our earth, and this explains the lightning and the storms which suddenly rise to wash its surface with their rains and cool the air. The time will come, we are sure, when this vast source of power will be harnessed, to light our homes, to warm our dwellings, to move our machinery. Then we have no reason to worry about the time coming when all our wood will be burned and all our coal exhausted. We are harnessing our waterfalls, turning their forces into electricity, thus using the heat force which lifted the water from lands and seas to drop as rain. But when there will not be enough coal for the use of the increasing population, men will use the flow of the tides caused by moon and sun attraction, they will tap the mighty streams of electricity flowing from sun and stars down on earth. Thus has a wise Providence foreseen and provided for all the wants of his highest creatures on earth, to whom he said: "Fill the earth and subdue it." Gen i. 28.

The electricity flowing from the sun is produced by the tremendous upheavals on a scale inconceivable, of fiery matters so hot as to be in a state of gases. A volcano is but a weak image of these seas, vast and deep, lashed in storms of fiery forces never at rest.

No eruptions of volcanic forces on earth in any way compare to those on the sun. The writer examined Vesuvius, and it seems that the internal fires blew the whole mountain-top off, sending the rocks ground into fine sand high into the air, and the vast masses fell down and overwhelmed Pompeii and the surrounding cities, covering them many feet deep with ground rock, incor-

rectly called "ashes." Then melted streams of rock, called lava, flowed down over the country, completing the destruction. The present Observatory, on the side of the mountain, is built on the granite foundations of the earth's crust, and is more or less free from the disturbances.

But the greatest display of volcanic forces of history was witnessed in 1883, when Mount Kraklao, near Java, blew its top off, grinding the rocks into the finest powder, which for more than three years, floated all over the world, causing most brilliant sunsets. The eruption was heard 3,000 miles away, broke windows 100 miles in all directions; a tidal wave, 100 feet high, swept 5 miles inland, and the disturbances encircled the whole earth as mighty waves in the atmosphere. Waves of ocean are never higher than 50 feet, 2,509 from crest to crest; their duration is 28 seconds, and they beat on the shores of ocean with a pressure of 3 tons to the square foot. But what are these compared to the awful eruptions and waves of fire which lash the surface of the sun! We can hardly draw a comparison between the forces exerted on earth with those on the sun.

What keeps up the vast light and heat he sends out every moment? Theories have been given by the learned. One school of scientists say great numbers of solids and gases floating in space are falling into him. These meteorites, much larger and more numerous than ever fall to earth, attracted by his mighty mass, fall with tremendous swiftness into the sun's fiery surface. The larger bodies, being miles in diameter, strike with awful velocity down through the glowing masses of metallic vapors, driving them aside, expose the darker flames of vaporized metals, and cause the sun-spots. The number and masses of these bodies, having been made at creation, and their flights having been fixed, just enough fall in regular periods, so they just sustain the loss of light and heat. Thus the Creator presides over them, so the light and heat are regulated from age to age.

But most careful observations, lasting years, do not show that the sun gets any larger, as it would if his mass was increased by these additions of matter. Nor do we find that his diameter at the equator is any larger than at the poles, as we see in all the planets. Mayer's great generalizations, worked out by Helmholtz, show that the light and heat of the sun remain constant, while its size is supposed to be getting smaller. But millions of years must pass before any great contraction can be measured.

Father's Secchi's measurements prove that all parts of the surface does not throw out light and heat in the same degree, for the regions round his equator are hotter than those of his poles. Helmholtz supposes that by slowly contracting the sun would keep up his energy for millions of years. Professor Tyndall estimates that if the earth fell into the sun, the impact would sustain his light and heat for 10,000,000 years. Professor Langley found that half the light and heat of the sun is absorbed by the vast deep oceans of glowing gases surrounding his surface. Learned men estimate that if large numbers of these supposed meteorites and little planetary bodies were falling into the sun, greater changes of light and heat would take place far beyond any experienced in geological epochs. Neither falling bodies, nor condensation, nor chemical changes fully explain how the sun's energy is sustained.

You cannot look at that globe of fire with naked eye except for a little while, for it is so hot its flames would destroy your eyesight. Then realize, that although it is 92,900,000 miles away, you see it as a round globe, for it is 850,000 miles in diameter. That fire differs not in nature from fire on earth, and the materials are the very same as those of our world.

More than 80 different primary metals and their unions and combinations compose this world, and most of these have been found in the sun. But it is supposed that many of these metals in the sun are torn asunder

by the intense heat, where they exist in forms unknown to us. That wonderful instrument, the spectroscope, reveals to us the metals of which the orb of day is composed. We have only to study the bright and dark lines in the sunlight, as the rays are spread out by the spectroscope, to find the metal which send out the light rays.

The ray helium sends from the sun showed us that metal in the sun long before it was found on earth. But in our day helium was discovered in the rare mineral clevite, and radium produces this helium, which is a gas lighter than hydrogen. The spectroscope also tells us the materials of which the stars are composed, and the condition of development of these far-away suns, many being of metallic vapors and gases in an intense state of heat. Let us see the surface of our sun more in detail.

What is the sun's surface glowing so bright? It is called the photosphere, "the light globe." In it more than 40 elements or materials of our earth have been discovered. Below it are the dark vapors of metals in an intense state of heat, but which give out less light than the bright carbon of the higher regions floating as a vast fiery atmosphere. Just above this, is another luminous layer, a few hundred miles thick, called the "reversing layer," consisting of metals in a state of gas, bright, but cooler than the matters below, because it is losing heat. We know the materials of this fiery atmosphere, because it absorbs the light that comes from below the sun's surface.

Higher still, over the sun's surface, is a vast mass of red, rosy, or scarlet emanations surrounding the sun to the depth of 4,000 miles. It is called the chromosphere, "the colored globe." It has serrated waving outlines, is subject to great changes, and forms the tremendous cyclones of fire seen during an eclipse. In some parts it is quiet, composed of clouds of fire of enormous extent, which keep their forms for a time. In other parts it is in a state of eruption, which shoot out in tree-like

flames and tremendous geyser-like eruptions, oft with a swiftness of 300 miles in a second, and which fall towards the surface with equal rapidity. These are composed of hydrogen, helium, coronium, calcium, and other light metals in a state of vapor, because of their intense heat. These gigantic forces, the extent of which we can have but a small idea, are seen especially during and near the sun-spots.

Higher still we find a bright white glory, called the corona, " the crown," like a gigantic halo or circle of light round the sun. It, too, is subject to changes. When the sun-spots diminish it grows greater, and diminishes as they increase. It is sometimes seen before sunrise and after sunset, but best during a total eclipse. At the total eclipse of July, 1878, the sun was clear of spots, and two brilliant streamers, one each side, extended from the sun's equator, stretching 10,000,000 miles, and the corona diminished towards the solar poles. At the eclipses of 1882 and 1883, when the sun was rich in spots, the corona was much smaller, but of high brilliancy. The corona's light is believed to come from glowing gases thrown out, from sunlight reflected from solid minute particles shot up into space, or from meteorites circling round before falling to keep up the light and heat. The spectrum shows a green line indicating a metal called coronium, but the rest of the spectrum shows reflected light. The enormous extent of the corona proves that electric repulsion has driven the gases to this great extent from the sun's surface.

Farther out is that mysterious zodiacal light, like a delicate nebula, oft seen in spring and fall, but best before sunrise along the plane of the sun's equator. It is often found extending beyond the earth's orbit. Some say it is caused by minute particles of matter driven out from the sun by his tremendous upheavals, others say it is electric, like the northern lights, and still others that it is of material similar to the tails of comets.

A careful examination of the sun shows it has nothing

like our atmosphere, water, or solid earth. The enormous heat turns every metal into gas, and the enormous force of gravitation keeps them in something like liquid forms. It is hard for us to have even a faint idea of the awful heat and mighty movements there taking place. The internal circulations, the faculæ, the sun-spots, the flaming coruscations, the eruptive protuberances, the bodies falling from the sky into the fiery mass, the uprushes and explosions, the internal agitation, the envelopes of fire, forming, breaking electric discharges, liquids changing to gases, and back again to liquids as they shoot more than 100,000 miles in a second on high, where they cool and become gases as they fall back into the fearful heat. Words fail to describe the mighty forces playing on the surface of our sun, which God made to give heat, light, electricity to earth that plant, animal and man might live.

The day the above was written many people in New York were prostrated by the heat, and 28 persons were killed in Philadelphia during a parade. If it were below freezing all the time, nothing could live on our planet. If the heat goes above 90 degrees in the shade, while the air is loaded with moisture so we cannot perspire, we suffer, and many die. We see therefore that the heat required for life ranges from 32 to 90 degrees, and that the sun's heat must be continued and regular.

Suppose our sun and earth were among the regions of the Milky Way, where vast changes and forces rage, we could not live. Suppose our earth were a planet revolving round Sirius, Regel or any of the great suns, our world would be melted with the fires of these mighty orbs. If we belonged to one of the colored suns their tremendous light and heat would overwhelm us and destroy all life. But Providence placed our world as one of the satellites of our yellow sun, in the middle of the universe, down far away from these upheavals and changes taking place in other parts of the universe.

What is the sun? When we see his surface and study

the physical changes on his surface, we will understand the other suns. The surface of our sun is a vast ocean of fire lashed by tremendous indescribable storms—cyclones causing changes in the climate of our earth.

At the Carnegie Solar Observatory at Mt. Wilson, near Pasadena, Cal., Professor Hale last year, with improved methods, photographed sun-spots with the spectroscope. In broad daylight red flames can be seen shooting from the sun's edge to great heights at a speed greater than a hundred miles a second and these are photographed by the new instrument when directed to the differet lines shown in the spectroscope. Calcium, vapor, carbon, hydrogen, and other metals in a state of gas are photographed at different heights in the glowing sun atmosphere. Marked differences are found at different elevations, and in the diverse metals. The spots show in the photos as whirlpools of fire of vast extent, which draw down the hydrogen gases. The materials round the spots take on a whirling motion like vast cyclones of whirling fire. The spots suck down into the interior the cool hydrogen and other gases like a gigantic maelstrom—all moving at the rate of about 60 miles a second. In about a day this hydrogen, heated to an enormous degree, begins to appear flowing out again, and after shooting up about 300,000 miles, falls down, spreads over his surface sending out heat and light; the flow keeping on for a couple of days. Thus day by day, lashed by vast storms of fire, swaying back and forth, up and down, waves that ocean 850,000 miles round our sun. Electric storms, displays of northern lights, magnetic disturbances, interfere with our telegraphs and telephones caused by these upheavals and sun-spots. Movements of our atmosphere, the seasons, winter and summer, are caused by the sun's heat. Periods of sun-activity, cold winters and dry spells, warm summers and wet springs, the varied changes of the seasons are remarked by all. Cyclones and blizzards, hurricanes and storms sweep over earth, often bringing destruction and

death. If we could foresee them we could provide. But, unfortunately, only in our day we began to study the weather, and meteorology is in its infancy. Our observations go back only about 70 years. During the civil war they began to record the observations of the weather, and now it is a part of the daily United States Government reports sent out to all parts of the country.

About 1830 they began in a systematic manner to study the sun-spots as indications of the sun's activity. But only in 1872 were they recorded in a scientific way as causing the weather changes of our atmosphere. Pouring out his light and heat down on to and through our air ocean, 100 miles deep surrounding our earth, the sun heats the air over lands and seas. The heated air becomes lighter, rises, and colder air sweeps in to take its place, causing winds. Round the equator the rays of light and heat are greatest, round the poles the cold is severe. Therefore, from the equator towards the poles, high up in the atmosphere, currents of air and great winds always circulate.

If the sun were constant in light and heat, the weather would be the same each season. But we know that the weather varies from year to year. Some winters are cold, others mild. Some summers there is much rain, while others are dry. Each continent has its own weather, with floods, droughts, famines. India sees millions of people die for want of food. Floods kill many in China, and in Australia 90 per cent of the sheep and cattle some years die. American farmers talk of dry and wet summers, cold and mild winters, late springs, cold falls. All these are caused by the changes in the sun. As our knowledge increases, we will be able to provide for these changes of climate.

Some years we find no spots on the sun's surface, other years we see many large spots and at other times they are very numerous. Sun-spots and their greater numbers denote a greater activity on his surface, which then throws out more light and heat. The prominences,

that is, the vast upheavals seen during eclipses, and which do not produce spots, show also changes, but our records of them began only in 1870. They are found all over his surface, while the spots are mostly along and near his equator. These prominences of fiery red color, shoot 100,000 miles high and are also as wide or wider. They also occur in cycles and often they are forerunners of spots. They are more numerous near the poles, and they show changes in his heat better than the spots. These prominences and spots, show variations of 4, 11, and 35 years in solar activity, and these are recorded by the barometer in our atmosphere. A fall of the barometer foretells rain, while a rise of the mercury shows clear weather, caused by a greater heat in the sun, which dries the air which holds the water in the atmosphere so the rain does not fall.

Bacon noticed the 35-year period of rainfall, and Bruckner worked on the problem. Father Secchi discovered the 11-year cycle of the sun-spots, and remarked that they correspond with the wet and dry periods. Learned men multiplied the short 3.8-year period of sun prominences by 3, and got 11.4; the changes of sun-spots, again by 3 and got 34.2; the other period of changes again by 3 and got 102.6 years, when the changes begin over again in the sun.

Lockyer compared these sun-spots and changes with the variations in the climate, and found they agreed. The short periods of 4 years were found more important than the 11 and 35 years of changes in the sun's activity, which cause the high and low pressures in our atmosphere. He found that while a high atmospheric pressure was on one side of the world, a low pressure prevailed on the other. When one side of the world has an excess of rains, the other has a dry season, and these are reversed the next year. When people suffer from drought in Asia, Australia, India, etc., the American continents are blessed with abundant rains; when rains and snows do not abound in America, the Orient

has them to repletion; but these changes vary because lands, seas, mountain ranges, deserts, etc., do not stretch out in regular form.

Here is the beginning of a science which will become most useful to mankind in future ages. But we have not observations of the sun-spots, protuberences and the rainfalls extending over a sufficient number of years to work out the problem, to foretell the weather, and the famines and misfortunes which afflict our race from time to time. The science has only begun. But people who live in and near deserts realize better the misfortune of a light rainfall.

The writer lived, during the year 1899, in California, most of the time in San Francisco. It seemed that nearly a fourth of the business places were deserted, because for two or three years the rainfall had been light all over the State. Farms were abandoned, crops dried up, fruit trees died, and you could see desolation along the railways in places where they could not bring water to irrigate the land. We see, therefore, how important a knowledge of the sun is to mankind, in order to provide for the droughts which afflict some regions.

But suppose a greater amount of matter now floated in the spaces between the stars, and it began to fall into our sun. The heat would be so great no rain would fall on any part of the earth. Springs, rivers and lakes would dry up. We cannot drink sea water, and we would all die. But the Creator made just enough matter to sustain the sun during the long ages while our race will live.

Let us imagine that in place of the vast quantity of carbon we see glowing on the sun's surface, there were aluminium, radium or some other metal which gives out not light but heat. We would not see the sun then, but we would be burned up with his invisible rays, no life could exist on our earth. We see, then, how beautifully things are balanced in the sun so as to keep his light and heat just right, so living beings might flourish

in his rays. A little more or a little less energy in the sun, and everything living on earth would be burned to ashes or frozen in everlasting frost. But it does not belong to the sun by nature to have just that amount of light and heat. For we find thousands of suns, some hotter and others cooler than our king of day. If our world were a planet belonging to one of these suns, life could not exist on its surface. Our sun belongs to the yellow stars, it is not too hot, like the violet suns, nor too cold, like the red stars; but just right for all the different kinds of living things sporting on the surface of our globe. Will any one say all these, and a thousand things we pass by, came by chance? Was there no One who marked out the forces, measured the materials and the laws of our sun from the beginning?

We can now tell the reader what a star is, for it is a sun so far away that you see it only as a little point of light. Keep before your mind the great size of our sun, the awful heat, the tremendous forces, the oceans of fire, the vast outbursts, the energy it is sending out into the spaces between the stars, the outbursts of flames, and you will realize what is taking place on the stars. Then get before your mind that there are over 500 millions of stars, some hold there are 1,000 millions of suns if all were counted on the photo plate. Just stop to think that each one of these stars is a sun like ours, some larger, a few smaller—then make a meditation on the power of Him who made them without an effort.

CHAPTER VIII.—MARS, VENTS, JUIPTER, SATURN, URANUS AND NEPTUNE.

Every little while accounts of imaginary beings living on the orbs and planets are published by people who do not take into account all the conditions required for life. For ages the "man on the moon" was talked of, but when the telescope was turned on our satellite it showed a dead, rocky surface without air or water, totally unfit to support life. Then they took up Mars and to-day we find these imaginary living beings are exploited.

Mars must be abandoned as a place of life. It has only a quarter as much atmosphere as our world on each square mile of surface, things there weigh only three-eighths what they do on earth, whence water would boil at 113 deg. F. while on earth at sea level it boils at 212 deg. F. If his atmosphere were one-tenth that of earth water would boil at 84 deg. F., therefore water evaporates or dries up rapidly on Mars, and would not flow 1,000 miles through the canals as irrigating ditches before it would all disappear. Besides, the planet has no free oxygen required for life; its plains are all colored rocks and plants cannot grow without soil washed with water and rain falling from clouds.

Eons of ages older than earth, for it is farther from the sun, formed of the very same materials as our world, its atmosphere is thinner than ours at an altitude of ten miles. As we climb high mountains we come to the limit of vegetation, above which nothing grows, for there the air is too rare to support life.

At Butte, Mont., the writer saw to what trouble the people went to make grass and shrubs grow round the homes. They brought plants from lower altitudes,

planted them with great care; they flourished for a few months then died, leaving dooryards bleak and bare with only a few mosses and algæ. Suppose you go up 10 to 15 miles above the Rocky Mountains, you would find conditions about the same as on Mars' surface. Two French balloonists ascended nearly 30,000 feet, one fainted, and both nearly lost their lives, but this was less than 6 miles, where the air is about twice as dense as on Mars' surface. Therefore no organism built as those of earth could live on this planet.

Aged and withered, its surface stretches out level showing a vast desert of rocky surface. Under direct rays of sunlight, its waters rapidly rise by evaporation from its surface, in the high altitudes turn to hoar-frost, and float towards the cold poles, where it falls as snow and ice. For this reason the poles are covered with white caps which gradually grow larger from fall to winter of the Martian climate. During spring and summer they melt away—one season the whole ice-cap disappeared from one pole. Like the earth, Mars is inclined to the ecliptic and these seasons alternate in the north and south regions or hemispheres like our winters and summers.

More than 200 years ago the polar snows were first seen, and most astronomers agree these polar caps are really formed of ice and snow. In modern days these ice-caps were found to be about 2,000 miles in diameter. But unlike our polar caps, they melt away to glistening patches of a few hundred miles during summers.

Some astronomers, following Mr. Wallace, suppose these white caps do not imply snow, but are white solidified gases or minerals. But as summer on the planet advances they disappear from spaces hundreds of miles across within a few days. It seems to most learned men they must be snow melting in the heat. A dark belt below girdles each shrinking white disk, keeping pace with it as it contracts. This belt is blue—the color of deep water. Professor Pickering turned the polariscope

on this blue belt and found by its reflected light that it is water. In these fleeting belts of blue under the ice-caps we see real polar seas, bodies of water caused by melting snow and ice, forming the white caps covering both poles. Because of the extreme thinness or tenuity of the atmosphere rain is impossible, a howling blizzard never sweeps over the surface of that planet, no snowdrifts pile up, no blinding gale or hurricane sweeps over the land; at most, mild zephyrs scatter gentle impalpable deposits of snow, mostly in the shape of hoar-frost, from the warmer equatorial regions to the far north and south poles. Now, how is this water brought from the poles back to the warm regions under and near the equator?

Night after night the writer looked at Mars through a telescope. He could see the planet as a round reddish globe floating majestically in the sky. He saw no white poles, nor could he distinguish any other feature. He did not have the trained eye of those who devote themselves to star-gazing. An Italian astronomer, Schiaparelli, first saw long bands he called "canals" and the discovery is one of the most noted of modern times. Within the last few years Lowell, Pickering and others devoted time and attention to these remarkable bands. For a long time they were doubted, their discoverer was accused of having drawn on his imagination, while others held they were optical illusions caused by tired eyes or by the movements of our atmosphere. As the canals appear only as flashes, some of the most painstaking observers did not believe their own eyes. But all doubts were removed about two years ago when Mr. Lampland succeeded in photographing them.

July 13, 1907, when Mars was nearest to earth—less than 38,000,000 miles away—astronomers with improved instruments saw his surface best and mapped out details down to from 5 to 20 miles. Photos brought out details eye cannot see, and now we know his surface better than parts of earth where man has never tred.

Mars has a mean temperature of 48° F., that of the

earth being 60° F. The poles of Mars are not as cold as those of the earth, nor its equator as warm as ours. But the sun looks down on Mars from a perfectly clear sky. Not a cloud appears, and the light and heat rays beam down as from a brazen sky on the flat, dried-up lifeless deserts which are appalling in desolation. Around the white snow-covered poles, and along their lower edges, are bands of shallow water, which freezes and thaws. The ice crusts must be very thin, for when the sun crosses the southern hemisphere the ice melts at the rate of six miles a day. Often during the Martian summer the white caps or ice-fields entirely disappear.

Ordinary readers hardly realize the difficulties astronomers meet, the long years of patient observations they must spend before publishing their discoveries to the world. Even when nearest earth, Mars seems no larger than a ball four inches, half a mile away, seen through a telescope. The lines representing the canals on this ball would be only a 30th of an inch wide, and the dots in which they end 10th inch in diameter. A telescope magnifying 75 diameters shows the planet as large as the full moon, but so much light is lost the face is dull and dim. When powers of 300 diameters are turned on, the planet is so dark you hardly see but its outlines.

But this is not all. If you were asked to read this page through a telescope 750 feet away while the book was made to dance in all directions, you would have an idea of the difficulties of studying the planet. The atmosphere surrounding our world miles high, because of winds and sunlight—this air is never quiet, but always in a state astronomers call "boiling," making the planet "dance" in all directions.

The reddish surface of the planet is a checkered expanse of blue-green and orange spaces. They called the greenish expanses seas, giving them poetic and mythological names. But they are all waterless deserts. Into their lowest parts the canals pour the waters from the

melting snows of the poles. The orange expanses were supposed to be continents, and received picturesque names. But there are no large bodies of water like our oceans on Mars. The bluish regions do not always retain this color, but change to orange. With the polariscope Pickering proved they are small bodies of water just under the edges of the melting snows. Mars is all land, except these portions around the poles and the canals.

The orange-colored parts are dry, rocky desert regions and the color seems to be caused by the rocks. But the surface of the planet is cut up into many triangular vast spaces by straight canals, or wide bands stretching mostly in straight lines meeting in round spots. In no case are these spots isolated, but three or more canals meet in each spot. These spots are in diameter from 35 to 150 miles, like the canals they appear and disappear with the latter, like opening and closing eyes, not all at the same time but with the disappearance of the canals debouching into them. They were first held to be lakes, and received names as of earthly bodies of water. They deepen in color as the season advances. The polariscope in the hands of Professor Pickering shows they are not all caused by water. Professor Lowell counted 185 of these remarkable spots. They are like vast pinheads in the desert landscape, the smallest being 35 miles across.

The early observers of Mars supposed the white polar caps were deposits of carbonic acid gas, or some other primary element, and the canals vast scratches like deep canyons in the planet's surface. But why these great ribbons would be formed with such geometrical exactness they do not explain. Others think these are furrows or great crack in the planet's surface, but they cannot explain why they are of this shape or extend for such distances in straight lines. When earth and moon were forming, vast volcanic forces lifted and formed the mountain chains and volcanoes, but why Mars does not show these same formations as earth we cannot explain.

Astronomers who like to fancy living, thinking beings on Mars say these canals and spots are irrigation canals, fields of vegetation, and that these valies bring the water through them from the poles. But how could men dig canals 35 miles wide and 1,700 miles long, and fill and empty them within a few days? They get over this diffiiculty by saying that they are the strips of vegetation growing on both edges of water-courses we cannot see, that the spots are great fields covered with verdure, and that these plants change the colors of these spots. But no living being on earth could live on Mars.

When the planet cooled, as in the case of the moon, it cracked by expansion, these great canyons called canals, miles across, were formed miles deep, down which pour the waters from the melting snows of the poles during changes of season, it is this water we see and not vegetation. This is the solution the writer offers.

There are no seas, oceans or large bodies of water except along the edges of the snow-cap. This water, like that of the ocean, is bluish green, and that gave rise to imaginary vegetation seen during his summers.

Mars is so far away from the sun he receives less than half the light and heat which fall on the same surface of our earth. The high dense atmosphere of our earth holds the heat, while the air on Mars is so thin, so rare, the heat escapes every night during which the waters turn to ice and snow. A planet must have a dense atmosphere just right for breathing, holding water which condenses round dust particles to become clouds which rain down water which plants drink. Many other conditions required for life are absent from Mars. He is a dead world, almost in the condition of the moon regarding life.

In the high, rare and clear atmosphere of the Flagstaff Observatory, Arizona, Professor Lowell, with his assistant, Mr. Lampland, at last succeeded in taking photographs of the canals of Mars with bioscope films. One showing the region called Syrtis Major, taken with a

very small diaphragm, agrees with a sketch made a short time before as of the planet seen through the telescope. This proves the canals are real objects and not optical delusions. The photo also clearly defines a large region to the south called Mare Erythracum separating this from the Mare Icarium—from Aeria on the north and from Deucalionis Regio. A bent line from the bottom turns sharply at its ends in the Nilosyrtis, and continuing westwards becomes the Protonilus. These remarkable photos show also Peboas Lacus. Astaboras, Vexillum, Casius, Toth, Pierius, and other objects are seen through the telescope, many of which were thought by some to be delusions of the observers. These were brought out by enlarging the small pictures. The disputes regarding these canals and objects on Mars, which raged for generations, are now ended.

The canal system extends through both dark and bright regions, ending at last in the polar ice-caps. During spring and summer in both hemispheres the canals are dark and salient, but in the Martian fall and winter they can hardly be made out. They do not develop till the melting of the snow is well under way, when they darken in a regular way proceeding from the snow-caps down towards the equator. This procession is so evident we can follow it 40 million miles away, and shows waters of the melting ice at the poles make the canals appear and disappear.

Earth, going faster in its flight round the sun, every second year overtakes Mars, but because of the tilted paths, once in 17 years they come close together. Telescopes magnifying from 350 to 500, making Mars about 25 times the size of the full moon to naked eye, bring out the planet as a beautiful colored map as clear cut as a steel engraving or photo.

The planet is a beautiful sight, colored in patches, having a perfectly level plain surface without mountain, hill, or vale, diversified with green patches, blue-green regions interspersed with reddish ground, crimsoned with

brilliant white—the smooth expanse extending all over the shining orb.

A system of lines like a gigantic spider web covers the surface, their order being surprising. These canals are traced with geometric precision, all lines leading to round centers, where from two to half a dozen lines end. At first the dark blue expanses were supposed to be oceans, but recent observations show them to be dry, dead deserts, the whole surface being a vast Sahara without a living thing—a waste of colored rocks without sand or soil.

A plain 30 miles in diameter on Mars, will appear in the telescope about as large as the dot over an "i" on this page. A city as large as Greater New York, or London, could not be seen on Mars, which is never less than 35 million miles away. These canals are therefore not less than from 15, 20 to 35 miles across. They are all very long, the longest would stretch across the American continent—many are shorter but they average about 1,700 miles.

The canals are not laid out in a haphazard whimsical way, every one is nearly straight and of the same width throughout, and stretching according to a well conceived plan. Many suppose them the work of thinking beings. Starting from some well-defined dark spot as a base, each stripe runs directly to some other dark spot, where it meets other stripes, so that several stripes converge in these spots. They run in all directions through the desolate surfaces of the planet. All are either perfectly straight or uniformly curved. They appear so narrow because so far away that we see them chiefly because of their great length. Each has about the same width through its whole length, and in each case converge in one common center.

These canals are puzzling. We find nothing like them on earth or moon. But the changes they present are still more startling. During a few days a canal will double—where a few days before only one was seen two will

appear. This their discoverer called "gemination"—a doubling. The photos taken at the Lowell Observatory show traces of this doubling, which was doubted long after Schiaparelli announced the fact even after he had spent years devoted to their study amid the ridicule of those who had not his acute eyesight. This doubling does not take place in all the bands. For out of the 400 canals plotted by Prof. Lowell, only 51 ever appeared double. If this peculiar doubling were an optical delusion, it would appear in all, and the photograph would not show them double. Why these phenomena take place we cannot say. It seems they are wide, deep depressions on the surface of the planet. They are long and of uniform width and appear like great straight canyons, often having another miles away parallel to them.

The canals look like spider webs, or telegraph lines stretched across the face of the planet. Prof. Lowell says the smallest is about 3, and the largest from 15 to 20 miles wide. Some are 2,000 miles long—2, 3, 4, 6 or more converge in a dark dot. The typical double canal called Phison is 2,250 miles long, 20 miles wide, the distance between the centers of the canals being 130 miles.

The dark round spots in which the canals end are large, medium, or small, the larger being more numerous, measures from 75 to 100 miles in diameter, and look like pinheads surrounded by other colored surfaces. The smaller seem like pin-points, and from 15 to 20 miles in diameter. The large canals end in larger spots and the small in the little ones.

Canals appear and disappear according to the Martian seasons; sometimes they are blotted out of whole regions to appear again. They appear after the melting of the polar snows. Spots change in the same way, both following the Martian year. Considerable time passes after the snow melts before canals and spots appear, those on the northern hemisphere appearing during the

summer, and those of the south show when the sun shines on the southern half of the planet.

Father Moreux, director of the Bourges Observatory, says the surface is composed of bright, light, and dark spaces, the "seas" being uniformly blue-green, a few showing a violet tint. The edges are not always sharp, the regions passing insensibly into greenish brown, then into chocolate brown in irregular marquetry. These changes do not follow the seasons of melting snows. The borders of the seas are always well defined, while those of the canals are dim, and vary from day to day.

Professor Poynting, by Stephen's law of fourth powers, holds the temperature of Mars' surface is at 40 deg. F. below zero, and that of the earth by the same law as 63 deg. F., which if correct regarding the mean temperature of our world, Mars' temperature is — 103 below that of the earth. If his figures are correct, how the snows melt in this cold, or how anything could live on Mars, we fail to see.

Articles are written about living beings on Mars, on the moon and planets by men who do not realize how impossible it would be for any organism to exist on these worlds. Let us give the experiences of scientific men of the observatory on Mt. Blanc, the highest peak in Europe. Janssen in 1893 founded an observatory on the top, where, since it was first ascended in 1786, the temperature was never above the freezing point except in 1906, when for a few minutes it stood at 36 F. Men can live there only from the beginning of June to the end of September. No human being could survive the whole winter.

Fouvielle, one of the astronomers, in his account of the work on the lone mountain-top dwells on the courage it takes to spend weeks in the monotony of these snow-fields and glaciers. The physical conditions cause a mental depression which is very hard to become accustomed to. The rapid evaporation of the moisture of the body causes an ever increasing thirst, while the appetite almost

entirely disappears. At first the system can stand only a few glasses of warm tea with plenty of sugar. Alcoholic drinks are deadly. The system rapidly runs down, but when the men get a little acclimated, they find meat the most nourishing food. But the meat must be frozen at Chamounix, then brought up and stored in the cellar where the temperature is always at from 12 to 15 deg. F. It is eaten with boiled vegetables to prevent scurvy and such disorders. Because of the rarity of the air it takes many hours to boil the food.

The men are clothed in Arctic garments day and night and the rooms heated to 32 deg. F. The moisture from the breaths condenses on walls and instruments in a covering of thin ice, icicles depending from ceilings, beams and lintels. When it gets a little warm, the ice melts and drops down as a rainfall in every room. They sleep in bags, and endure all kinds of miseries looking forward to the time in the fall, when they will be relieved from the living death. If men suffer such miseries on Mt. Blanc and on high mountains, how could they live on Mars, where the conditions are the same as 10 miles higher than our most lofty mountains?

A man made to live on Mars must have lungs of far different capacity than ours, with trunk, legs and limbs in proportion. He would hardly resemble a human being. Animals would differ from all beasts of earth, and plants would have to be formed of different structure from ours.

An inhabitant of Mars would be much more powerful than our strongest man, for Mars' mass is only one-ninth that of earth. He could run 10 feet in a second, jump over a tree, and kick a football a quarter of a mile. He would have to be 18 or 20 ft. high, his muscles would be 27 times stronger than ours. Bodies would weigh only a third as much as they do on earth. A laborer there could do as much work as 50 or 60 men on earth, and he could keep up to a powerful Panama dredger which lifts 2 cubic yards of earth and fills a car with one sweep. He

could pick up 2½ tons, and run off with the load on his back.

The stories of the inhabitants of Mars are all fables—fictions of the fancy. The air there is too thin, the surface is all desert rock, there is no soil for vegetation, there is not enough vapor of water to condense as rain in its atmosphere to sustain life, and the pressure of the atmosphere is too light. A thousand conditions prevail there which would kill every living thing.

Venus comes nearer earth than any other planet except the moon. It revolves round the sun in 224½ days, and is seen as evening and morning star. As her distance from the sun is about two-thirds that of the earth, her distance from us once during every revolution, is only a third that of the earth from the king of day. She increases and diminishes in apparent diameter, and presents phases similar to those of the moon.

When nearest earth as seen through the telescope she turns her dark side to us, but a few days later she shows a slender crescent of light which widens more and more as she swings round in her path, while shining as the morning star bfeore sunrise. Gradually she assumes the form of a half-moon, more and more of her face lights up, till at last we see her whole disk. But then she is on the other side of the sun from us—lost in his rays. Then her face undergoes the same changes in the opposite direction. She appears to the east of the sun, till she swings round in her orbit, and comes back again to her nearest position to the earth. She is therefore very hard to study, because when nearest to us she is dark, and when she shows her full face we are blinded by the splendors of sunlight. We therefore never see the whole face of the planet, and we have not such a complete knowledge of her as we have of Mars or of the moon.

During a transit of Venus, we see the planet pass across the sun's disk as a thin half crescent band like the moon in its first quarter. The points seem to hang over the limb of the sun because the sunlight passing

through the planet's atmosphere is refracted. Measuring the air or gas enveloping Venus, we find it is twice as high as our air, and if it is like our atmosphere it must be twice as dense. Now if our air were twice as high as it is it would press with a weight of about 30 pounds to the square inch on us in place of only about 14 pounds, as now. No man, animal, or plant could live under that pressure all the time. Men building tunnels and caissons under this pressure can work only about three hours at a time, and many die. Some astronomers estimate that Venus' atmosphere is five times as high as our air. The spectroscope shows water vapor in the shape of clouds float in her atmosphere, and these clouds are so deep and dense that it is very hard to see the planet's surface.

Venus receives on each square of surface double the light and heat falling on the same space of earth. Recent observations show she rotates on her axis only once while revolving round the sun; therefore she presents one face to the lord of day as the moon shows only one side to the earth. One side of Venus has therefore everlasting day, and the other perpetual night. The side which is forever dark has the interstellar cold of the spaces between the stars.

For this reason her rotation was hard to determine, for we could not find a fixed spot on the surface, all seen being changing clouds. Drawings made at the same time by different parties do not agree. Cassini made the first drawings in 1666, and other astronomers worked on the problem of her rotation on her axis. Herschel with his great experience and ability abandoned his observations on this planet. But in 1878 Schiaparelli, after very careful observations at Milan, announced that he could not agree with others who stated that the planet revolved either in 24 hours, or in 23 days as given out by former scientists. Having eyes which first saw the canals of Mars, his words have weight. He holds that

she revolves only once during her path round the sun, and therefore presents the same face to the orb of day.

In 1896 studies of the planet in broad daylight confirmed Schiaparelli's conclusions. At the Lick Observatory Mr. Bernard, even in the high pure air of California, could find no spot save once. Flammarion tried to combine all the details of former observers and drawings, and he came to the conclusion that many belts and spots were illusions. Venus' black lines and belts are much like those seen on Jupiter's satellites, and some believed them to be shadows of clouds thrown on the surface of the planet. But the conclusions of the best informed observers is, that we never see the surface of the planet itself, only diffused light and clouds floating in the atmosphere. As it receives almost double the amount of heat as the earth, one side of the planet with its everlasting day is burned up, and the other side of the perpetual night has the cold of the interstellar spaces 449 deg. below zero. Nothing could live on Venus, for the changes of heat and cold are too great for any kind of life.

Its mass being a little more than three-fourths that of the earth, it could retain air, water, and the same gases we find on earth. The clouds floating in its air would modify the heat in a measure, but not enough for living organisms. Besides we do not know if these gases are the same as those forming air and water of our earth, which are absolutely required for life, if the heat and cold were not so extreme.

As Venus turns one side towards the sun all the time, similar to the moon which turns towards the earth, therefore vast cyclones and whirlwinds of heated air like blasts from fiery furnaces rush from the light to the dark half of the planet, while at the same time the cold winds hundreds of degrees below the freezing point sweep in from the dark cold half to take their places. If living organisms could survive the heat they would be frozen with the cold.

Mercury keeps one face always turned towards the sun, so life there would have the same difficulties to overcome as on Venus. But as it is much nearer the sun, its contrasts of heat, cold and light are much greater. Its mass being only one-thirtieth that of the earth, water-vapor or steam would certainly escape into space, and if it once had water, this long ago was dissipated into the interstellar spaces. Weight being so light on this planet the three gases, oxygen, hydrogen and nitrogen would also escape. Mercury has neither air nor water, absolutely necessary for any living organism. It reflects no less than 83 per cent. of the sunlight, more than any other planet, whereas clouds reflect 72 per cent., showing it has neither air or water. The side turned from the sun in everlasting darkness is frozen below 300 deg. F., and the face which turns to the sun forever is intensely heated even to the melting point of rock, therefore this planet has no life. As to the planet Vulcan some suppose they saw, the conditions would be still more unfriendly for living beings. The conclusion then is irresistible that the smaller planets have no living beings.

Now let us go beyond Mars and see the great outer planets. We will pass by the 500 smaller asteroids—little planets, some of them being only a few hundred miles in diameter. It is certain nothing can live on them, for they have no air or water.

Jupiter comes next—being the largest of all the planets. But as he is five times farther from the sun than our earth, he receives only a twenty-fifth part of the light and heat which falls on the same surface of our world. Supposing that the light and heat of the earth decreased to the twenty-fifth part of what we now receive, how long before every particle of water, and every living organism would be frozen? Nothing now living on earth could continue in this cold; ocean, lake and river would turn to ice, the gases would become liquids, the whole climate would become colder than the most arctic night.

Jupiter, Saturn, Uranus and Neptune have such low

densities, combined with large size, that nothing solid can be on them. They are formed of metallic vapors, clouds of metals so hot that nothing solid exists on their surfaces. Could a living organism exist in a cloud as hot as a furnace blast? Jupiter has less than a fourth of the density of the earth. Saturn less than an eighth, and Neptune and Uranus between these two figures. The bodies of the solar system are therefore divided into groups—the inner ones, including earth, are, like it, solid; because of their smaller sizes they cooled rapidly while the outer planets, beginning with Jupiter, being very large, are formed of vapors and gases, which can be liquefied only at very low temperatures. Their enormous bulks with low density accounts for these conditions. Mercury, Venus, Earth and Mars are more or less alike, they are all small, the earth being the largest and all have nearly the same density.

Saturn, 872,137,000 miles from the sun, moves so slowly Hindoos call it Sanaistshara, "Slowly moving," goes round the sun in 29½ years, is the next largest planet after Jupiter, is inclined to the plane of its path 27 deg., and has four seasons each equal to seven of our years. Its mass is 93 times that of the earth and has twice as much matter as Mercury, Venus, Earth, Mars, Uranus and Neptune combined. Its diameter at the equator is 73,000, and at the poles 66,000 miles and is 895 million miles from the sun, receiving only one-ninetieth of the light in brightness we do. It is encircled by six rings, the most mysterious objects in nature.

This planet is so hot, it shines with a dim light, which in the spectroscope shows dark absorption bands in the red and orange like those of Neptune, with signs of hydrogen. Its atmosphere is filled with great clouds, metallic vapor, steam, etc., seen as dark broad bands to the equator, from which Sir Wm. Herschel estimated its rotation at 10 hours, 16 minutes. If it revolved 2½ times faster things would have no weight on its surface, and if three times faster the planet would be broken into

one or more planets, for it would burst like a wheel turned too fast.

The rings revolve in 10 hours 20 minutes. They are not solid but are composed of gases mixed with little grains of dust, rocks, mountains separated one from another each independent and moving like little planets all held by weight. The inner ring called gause or crepe is 6,400 miles from the planet, 8,400 miles wide, and astronomers have seen it divided into many concentric rings. In 1905 its satellite or moon Iapetus passed through this ring, through which the body of Saturn can be seen in undiminished brightness.

This dim ring gradually merges into a brighter ring outside it 18,000 miles wide, 1,450 miles separating them. Outside of this is another very bright ring 10,000 miles wide, its outer edges being 45 miles from the planet's surface. These rings are separated into 6 rings, like the rim of a hat, round the planet, and have no atmosphere. During the planet's revolution round the sun, twice they vanish into a narrow line, and twice open into broad ovals above and below, and when Saturn crosses between us and the sun they disappear.

The spectra of the planets tell peculiar stories. That of the rings of Saturn shows the inner rings move faster than the outer rings; the rings, therefore, are not solid but composed of millions of small detached bodies and gases all moving independent of their neighbors. The rings may be compared to numberless little planets revolving round the great planet.

The lines of the spectrum of Saturn and of Venus all lean over to the left—that is, they are not straight up and down as the lines in the specra of he sun and stars, but oblique. This leaning over shows that the planets revolving throw the lines of the reflected sunlight over this way as the recent spectroscope observations at Flagstaff show.

Saturn has 10 moons. Phebe, the 9th, discovered by the photograph in 1889, seen again in 1904, has a diame-

ter of 198 miles, revolves in 547 days, and shines as a star of the 15th magnitude 8,430,000 miles from Saturn. Eros, first seen by Witt in 1898, is so far from Saturn that in one part of its revolution it comes nearest to the earth of all the heavenly bodies except the moon. Jupiter has 6 satellites, the last discovered revolves in 248 days. Fifty-nine little asteroids were discovered in 1904. Thus far were found more than 500 revolving between Mars and Saturn and new ones are being found every year. They are of all sizes from a few hundred miles diameter to a few miles, some having about the mass of one of our large mountains.

Men ask, are the laws of gravity, of stellar motions, of solar physics, of astronomy right? Is the theory of the heavens correct as science proposes? A startling discovery was to prove the science of the stars correct. Certain perturbations were noticed in the planets. They were pulled out of their place in a certain part of their orbits. This could be explained only by the existence of a certain mass of matter never seen by mortal eye. Mathematics proved it was there. Two men worked on the problem unknown to each other, one Adams, an Englishman, the other Leverrier, a French astronomer. On September 23, 1846, astronomers turned their telescopes to the point the figures indicated, and discovered the planet Uranus. This brilliant piece of work proved our system of the heavens correct.

CHAPTER IX.—THE MOON AND WHAT WE SEE ON HER SURFACE.

The moon, ever orb of mystery, poetry, song, was dream of astrologers in olden days, when her changes were supposed to control human lives and modify the weather. Reigning over empire of silence and peace, its white and frosty light with silver gleam seemed greatest of heavenly mysteries. Pagans called her "queen of night," "Diana with silver crescent," "Phœbus with fair hair," "Cynthia with her beams." In far-off days in Babylonia she was worshipped as a goddess, her cult crystallized into temple and ceremony at Ur: "light," where Abraham lived before God called him into Palestine. The adoration of the moon spread over the world in days of deepest paganism.

Born of earth when worlds were made under God's guiding hand, the moon is attached to our world by ties of attraction, her weight keeps her in her course, and ever on she sweeps round earth in about 29 days, circling from west to east like all the other planets.

When, 300 years ago, the telescope was first turned on the moon, nearest of the heavenly bodies, our satellite excited the greatest curiosity. Galileo's observations made more noise than the discovery of America had some time before. For a new world had been found, not on earth but in the heavens. Excited minds thought they saw "a man in the moon," as well as cities, lands and continents peopled by reasonable beings. Voyages, romances, novels, excursions and wonderful discoveries were published and read with avidity, as to-day wild stories are read regarding life and reasonable beings on other planets.

Naked eye sees bright and dark regions on moon's surface, and these were supposed to be reflections of

our world, continents and seas. When the telescope was invented, learned men set to work to unravel the mysteries of our satelite. They saw her face composed of mountain, hill, plain and depression, and found the changing phases of new, old, half, quarter, and full moon were caused by the sunlight reflected to us during the different positions of our neighbor regarding earth and sun. These are simply lights and shadows on her surface. The moon does not shine with her own light as the ancients supposed, but reflects the sunlight from her white rocks.

Learned men surveyed her face and published maps called selenographic drawings, from Selene, the Greek for moon. Soon the moon's surface was surveyed and mapped out better than the surface of the earth, for parts of our world had not then been visited.

Psalm viii, 4: "For I will behold thy heavens, the works of thy fingers, the moon and the stars which thou hast found," has been paraphrased as follows:

"Soon as the evening shades prevail,
The moon takes up the wonderous tale,
And nightly to the list'ning earth
Repeats the story of her birth;
While all the stars that round her burn,
And all the planets, in their turn
Confirm the tidings as they roll,
And spread the truth from pole to pole.
What though in solemn silence all
Move round this dark terrestrial ball?
What though no real voice, nor sound,
Amid their radiant orbs be found?
In reason's ear they all rejoice
And utter forth a glorious voice.
Forever singing, as they shine,
'THE HAND THAT MADE US IS DIVINE.'"

Earth is 7,912 miles in diameter, its surface has 148,570,000 square miles, 55,000,000 of land as some estimate—the land has not yet been exactly measured—and weighs 259,375,000,000 long tons. But the moon, much smaller, has a diameter of 2,160 miles, a surface of 14,657,000 square miles and 5,276,000 cubic miles,

which Cavendish says weighs 73 trillion tons. A globe of water the size of the moon would weigh 21½ trillion tons, it is .062 the density of our earth, showing moon rocks are much lighter than rocks of earth. Moon's mass is 1-80 that of earth, a pound on the moon is only ⅙ as heavy as on earth—2½ ounces, and a man who could jump 6 feet here could jump 36 feet on the moon.

Although the moon's mean distance is 240,000, when nearest it is only 225,719 from us. A thing dropped that distance would fall to earth in 3 days, 1 hour and 45 minutes. If we could take an ordinary railroad train to the moon it would take us about a year to get there.

Some years ago Professor Darwin of Harvard suggested the moon was once a part of the earth, thrown from it by centrifugal force, when like a wheel revolving too fast our planet burst. The theory was subjected to mathematical examination and is now a classic held by all astronomers. The earth then melted by heat caused by condensing, revolved faster and faster till it turned on its axis in about 5 hours, bulged out at the equator forming a great pear-shaped mass, as tides act on a smaller scale to-day. Revolving too fast for the materials to be held by weight, when the speed came to a certain rapidity, the melted matter now composing the moon was thrown off and formed our satellite.

When did the moon separate from the earth? Long ages ago, the exact date perhaps we will never find, but it was after our earth had cooled, when a rock crust 45 miles deep covered its surface, its interior still being fluid with heat, when all the matter forming the earth melted, the heavier metals settled down deep into the interior. They were thrown up in small quantities in the great convulsions from the fiery deeps, when the mountain chains were formed. Therefore heavy minerals such as gold, iron, etc., are generally found among the rocks formed by fire. There are millions of tons of gold, silver, iron, platinum and rare metals in the

earth, but they are down deep near the center. We find only small amounts where fiery eruptions raged, amid the mighty mountains and solid crusts of our planet—hardly ever in rocks formed by water.

Rocks on the surface of the earth are much lighter than those down deep in the interior. Water, air and gases being light, did not sink down into the melted earth—now they float over its surface. What wisdom it was to give these gases and fluids this light weight, for without them we could not live! Wisdow foresaw life was to be created here, and endowed the different materials with weight and activities with that purpose in view.

The weight of the whole earth, or its density, is about 5.6 the density of water—that is, it weighs 5.6 times more than would a globe of water the same size, while the weight of the moon is 3.4 times more than a globe of water of the same size. If we could strip off 45 miles of its surface all around and weigh it, the materials of the crust of the earth would be found 2.7 times heavier than an equal quantity of water. The materials of the moon being 3.4 and of the earth surface 2.7, the weight of water, their density hardly differ. As the moon was scraped from the surface of the earth some materials were taken from down deep, where the materials are heavier than on the surface. That is the reason the difference between 3.4 and 2.7 is so very small—.7, between the weight of materials on the surface of earth and of the whole mass of the moon. In this mighty upheaval of matter from the earth, while the moon's mass was liquid with fire, the moon's heavier metals fell towards the earth, being drawn by earth's attractions. Thus the center of gravity of the moon is 33 miles nearer to us than the center of the moon. Earth and moon attract each other, the moon therefore cannot turn over, for it would be like going uphill. Therefore our saaellite turns one face to us all the time.

The Bible account only states the fact. "And God

said: Let there be lights in the firmament of heaven, to divide the day and night; and let them be for signs, and for seasons, and for days, and for years. To shine in the firmament of heaven, and to give light upon the earth. And God made two great lights, a greater light to rule the day, and a lesser light to rule the night, and the stars. And he set them in the firmament of heaven to shine upon the earth."—Gen. i. 14-16.

The continents are of materials about as dense or heavy as the great mass of the moon. The laws of whirling wheels and turning globes show how the moon's mass was torn from our world after the surface cooled. The steam condensed to water which covered most of the earth's surface, in these far-off times when the mass composing the moon began to rise by centrifugal force, which bursts a wheel revolved too rapidly.

As the earth revolved too fast, scientists say a part of the solid crust near the present islands of New Zealand began to rise in the air. A great crack in the crust on the opposite side of earth appeared, got larger and wider, and the American continents slid over towards the Pacific. The chasm became 2,000 miles wide, the waters flowed into it and formed the Atlantic Ocean. On the opposite side of the globe the great continents covering nearly three quarters of the surface of the earth rose on high, separated farther and higher, its materials fell together forming a globe, for that is the law of the whirling orbs. Turning, whirling round the earth in 5 or 6 hours, as it ascended, its rotation round the earth became slower, till when it got 240,000 miles up in the sky, just where its force tending to fly away just balanced its force of gravity, weight, tending to make it fall to the earth, then it stopped. Who stopped it? The Creator who knew just its weight and the weight of the earth. There is now the moon revolving round the world "the lesser light" to rule the night. Gen. i. 16.

As the moon's mass rose it dragged materials from

down deep below the surface of our planet. Then it left as its mark the great Australia with islands to northwest, and our Philippine Islands. The deep wide chasm from whence it was torn is now filled with waters of the Pacific. Right in the center of the Pacific from which came our moon, northeast of New Zealand are the deepest waters of earth, its opposite point being in about the center of the Sahara desert of Africa. What a wonderful upheaval that was!

The center of gravity of the earth does not agree with the center of the figure, for the materials of the continents are lighter than the materials forming the ocean-beds. Ocean floors are vast extending plains or plateaus having an average depth of about 3 miles. The land surfaces then floated like ice-cakes on the melted matter of earth when the moon was torn out. The average density of the continents is 3.4 that of water while that of the moon is 3.4, exactly the same. If the moon were not taken from the earth this way, taking only a part of its surface, the earth would be almost all covered with water. For then the cooling globe would be almost round, the condensed water would have completely covered its surface, little or no land would appear, mankind could not live. If all the hard crusts of the earth had been stripped from its surface, and formed into a great globe twice as large as the moon, the waters would cover a smaller earth, things could not grow, for the whole surface of the world would be covered with water, the materials of the earth would weigh much less, the whole order of nature on earth would have to be reorganized. Who says no Architect planned out these things?

If now we look along the edges of this deep depression of the Pacific, we find it bordered with lines of active or extinct volcanoes stretching in curves where the continents were broken in the upheaval and islands. These continents inclosing the Pacific are lined with lofty mountain ranges, remains of melted ridges

thrown up. These are peculiar to the Pacific coasts, while the Atlantic coasts are mostly low or level plains, showing the continents were split apart when the American continents were dragged over to where they are now.

Geologists also say a large continent sank in the Atlantic of which a tradition comes down among many races. That is why the Atlantic is so wide between Central America and Africa. Tremendous seems these upheavals—the tearing out of a planet, the sliding over of two continents. But what are these exhibitions of power compared to that of building suns as we have explained! They are the marks of the fingers of God.

There is no other way of explaining how the moon separated from our earth except that God ruled nature at the lunar birth. For when we go down deep into the questions, ask how the earth revolved on its axis in 5 hours to burst like a mighty wheel, how it changed to turn in 24 hours, why the moon revolves round the earth in about 29 days when it once went round in 5 hours, why it stopped when just 240,000 miles away, why it did not go on away to be lost amid the star deeps —a thousand questions like these come into the mind to which we find science gives no replies. The only answer is that a Power infinite, a Wisdom learned in figures, a Mind eternal presides over the formation of the orbs, and ruled nature in these eons of ages when orbs were made. Men like to leave out God. They go into the questions of the tides, tell how many millions of years it would take the tides to retard earth's rotation at a fraction of second in a century, and use figures to explain these things, but all admit we are on the borders of human knowledge. The simple old woman who says when she sees things she does not understand, "Glory be to God" shows more wisdom than the most learned scientist, who looks to nature alone to unravel the mysteries of matter.

When the writer traveled along the shores of the

Pacific, he found the mountains then composed mostly of white rocks. The crust of the earth sent up from below by volcanic forces is almost as white as chalk. The moon seen through a great telescope is formed of white rocks, which look exactly like the rocks along the Pacific. The writer has never seen this comparison stated, but it seems to strengthen the theory.

As time went on earth and moon by their attraction gathered in materials from the sky, which falling with the swiftness of heavenly bodies continued to keep up their light and heat. Then earth and moon shone like suns with their own light. But as ages passed they gathered in all the matter God made floating in the star spaces nearby. Gradually both bodies cooled when there was nothing left to keep up their heat when all the material had fallen on their surfaces. A cooled crust of rock covered their surfaces, but the interiors of the planets were still fiery masses of melted rock. The earth being much larger than the moon still preserves the fires of the interior we see driven forth from volcanoes.

As the cool crust covered the moon's surface, the fires beneath continued their activities and burst forth in countless volcanoes. As the planet lost its heat, it contracted, the crust broke and sent up through the great cracks the melted materials which built up the mountain ranges on the moon. But in every place belched up gases, flames and melted rock as you see bubbles rise when thick pudding is cooking or bubbles rise from stagnant pools.

During eons of ages ago, higher and higher mounted the fiery forms of red-hot rocks. Incandescent clouds of rocks ground into sand, called ashes, shot out from vast volcanoes, then parting and spreading into pine-tree forms, these fine broken rocks, ground by the tremendous forces of the interior, were dragged down under the force of gravitation. Hundreds of thousands of craters sent up these materials high towards the sky, as the younger Pliny saw the top of Vesuvius blown

off, when the fiery mountain destroyed Pompeii with a rain of fine sand, as when the melted rock in lava form of rivers of fire overwhelmed Herculaneum. Each cone sent forth the semblance of a monstrous palm-tree redly magnificent, showering fiery materials down on the plains till they built up the round rings of melted matter, and rings of vast mountains surrounding the great volcanoes now extinct.

No man was there then to see these gigantic geysers of liquid fire, as fountains from the deeps spouted forth melted materials from the interior, remains of the transcendent forces of gravitation which drew together the matter of which our moon was made. No one saw the erect fiery fountains that spread widely at their tops, arching like a stream of water from a hose with a nozzle miles in diameter, or when they burst like Roman candles into scarlet showers. Each forming an island of fire on the melted plain covered the planet with fire and mineral vapors. Earthquakes, upheavals, seas of fire sported on every side a million times greater than we see in the crucible while they make steel.

As ages pass her tremendous heat was lost in the interstellar spaces. The mountains cooled quickly and became like glass, the plains longer retained the heat, and there the rocks are crystallized into granite. You will see along the sides of Vesuvius that the quickly cooled rocks are like black and gray glass. But where large masses of lava of the volcano flow down and retain the heat, they crystallize and show the form of the granite of which the crust of our earth is made.

But the cones within the great volcanic moon rings longer retained their heat, and glowed like molten metals. Often it flowed like iron from a furnace, filling the round crater floors. Then rivers of fire spurted out from the bases of the cones amid metallic gases, looking like imps of hell breaking from infernal regions. Red-hot boulders were shot forth, as from gigantic cannons. Falling they floated on these seas of melted

matter, or helped to build up the central cones. Often they stuck to the plastic sides, when they fell near the crater which belched them forth. Some of these rocks shot up were as large as hills or mountains, others the size of houses, others smaller—they were of all sizes, all hot nearly at the melting point.

Now all is cold. The fires which shaped the planet now are gone, we see but their remains on every side. Silence deep broods over the wild scene of vale, and mount and crag and plain. The loneliness of the dead world is appalling to us used to life, and movement, and change and variety of earth.

The naked eye sees the moon's surface mottled with shadows, shades and light, having dark regions extending over its surface, with here and there round patches of light. These never change except while making her circuit round the earth in 29 days, 12 hours, 44 minutes, 2 seconds, the sunlight illumines them from different sides. As the moon rises above the horizon and sets in the west, we can look down on her upper and lower sides, as it were see over on to the places we cannot see when she is over our head. Galileo first explained the phenomena when he turned on our satellite his newly invented telescope, and what he saw upset wild fancies of former observers.

He first saw the mountains, vales and plains, and announced her surface is not flat as Aristotle's followers taught. His glass revealed our nearest heavenly orb, like our earth, is covered with hills, depressions, mounts, vales and plains. Nearly 30 years ago the writer first saw the moon through the great telescope of the Dudley Observatory, and it was a sight which never will be blotted from his memory. The great round globe stands out, not flat, as seen with the naked eye, but round like a giant globe moving in majesty along without support. The lights on the mountains were very brilliant, as the crater edges flashed back the sunlight.

The surface of the moon viewed through a telescope of one of our observatories is seen all covered with spots. Her surface is scared with depressions like those left by the smallpox in a person's face. They are nearly all over the surface—some are nearly 100 miles across, others so small we can hardly see them. In some cases they are round valleys below the surface, in others the ridges are high over the plain, but many depressions are below the lunar landscape. Many are round prominences above the plain, while others, especially the medium sized, have one or more round cones in their centers.

What caused these peculiar formations? Some say they are all of volcanic formation. Mr. Tozer holds that they are caused by meteorites falling on the surface when it was fluid; in a melted state. These bodies falling down with terrific velocity, caused by the moon's attraction, splashed the molten soft rocky surface of our satellite like the pebbles you throw into water. These meteoric bodies, coming from the sky with the swiftness of planets, from 20 miles diameter to a few feet, they fell down while the planet was in a melted state and caused the peculiar round craters seen all over her surface.

Professor Brashear took plastic clay, wet and easily molded, and with it covered a large surface. Then he threw balls of the same material with great force down on the surface of this soft clay. The balls sank down into the soft surface, which was soon all covered with depressions, round ridges, with central cones, the marks on all sides strikingly like the moon's landscape. This seems to prove that these mountains and the mottled surface of our planet were caused by the materials like meteors falling from the sky while she was cooling. But there are other phases of formation which only volcanic action could cause.

Through the great equatorial of one of our observatories the moon is the greatest sight. The clockwork

keeps the whole glimmering globe in the field of vision. It looks not flat as seen it with naked eye, but as a round globe hanging high in heaven. The plains, mountains, hills and depressions appear with striking vividness. The places where the light strikes are very bright, but the shades are of inky blackness. You can see the projections throwing their dark shadows. The plains are gray and the white mountains stand out as rugged patches and ranges of light. The flat rocky pock-marked plains are spotted with round deep depressions, most of them having a cone in the center—they look as though some mighty hand threw mountains from some awful height down into the plastic, melted, rocky surface, as you would throw pebbles into thick mud and then the whole surface had solidified into rock, leaving round cones in the center of each depression some of them being miles across.

When the moon's mass was fluid, melted with heat, the rapid turning of the moon around the earth caused great tides in its mass, so that it became elongated on the side turned towards us, and on the side away from the earth. The heavy materials fell down through the center towards the earth because of the attraction of our greater mass. The center of the gravity of the moon is not in the center of the mass, but about 33 miles nearer to us. For this reason the moon never turns over, but presents the same face to us all the time. No man ever saw the other side of the moon. It tilts a little, swinging back and forth so we see somewhat over the rim, but that is all. What there is on the other side we do not know, nor will we ever find by direct sight.

As you look up at that round ball of shining solid rock seeming to rest motionless in your field of vision, you ask yourself why it does not fall to earth. Because it has two movements, centrifugal and centripetal, which exactly balance each other. The earth's attraction for it, and it for the earth, and its movements round the earth, both keep it where the Creator placed it. Newton,

searching into the mysteries of nature, saw in every part of the universe the Eternal's footprints. He was so struck with the wonders of creation, that whenever he heard the name of God he took off his hat and bowed his head in adoration of Him, whose wonders he had spent his life investigating. Only little or ignorant minds cannot see God in His wonderful works.

Newton, in his great work the Principia, analyzed the two forces to which the moon is subject—movement round earth, and tendency to fall down on our world; but we will give only a few of his conclusions. As the moon falls it goes along and each moment it is the same distance from the earth.

It is subject to two movements—centripetal and centrifugal—one tends to bring it nearer earth, the other tends to make it fly away—one balances the other. As its attraction for earth and earth for her forever pulls the two orbs together, the circuit motion of the moon tends to make it fly away. But these two forces exactly balance, and it stays up there, 240,000 miles high, resting on nothing.

Suppose it were twice that distance, attraction would be so much less it would go slower and slower, farther and farther away, get beyond the pull of the earth till it went wandering through space. Suppose it were half that distance, it would whirl round the earth faster and faster, come nearer and nearer, till at last it would strike our world and overwhelm everything. Then the two globes would smash and fuse into one great fiery globe.

Now to make these two forces, movement and weight, exactly balance, it was necessary to put the earth and moon just so far apart so one force equals the other. To know just where to put the moon so it would stay there, it was necessary to weigh every grain of matter in both orbs, and to give the moon just that movement round the earth.

Not only earth and moon are founded on these simple laws, but the hundreds of orbs of the solar system.

But that is not all. We have explained that the photos show about 500,000,000 of suns in the heavens, the spectroscope tells us most of them are double, triple, or formed of four or more orbs gyrating round each other. We have therefore not less than 1,000 million planets and suns circling round each other. To put these in their places, just so near and far, to give them their different movements so they would go on forever, it was absolutely necessary to weigh every particle of matter in each, and in all, otherwise the mechanics of the stars would be in time destroyed. Who could do that but a Person infinite in power and wisdom? Any other idea is simply unthinkable. Yet we find men so ignorant they cannot write an article without showing bad grammar, spelling and faulty composition, who say there is no God. Are these men insane?

Fancy of astrologers had given names to places and objects of the moon long before a telescope had been invented. The large plains they called seas, the small ones marshes, and they imposed titles of lakes, or landscapes, mountains, valleys, gulfs, peninsulas, rivers, etc. These names have been retained. Whence we have Sea of Plenty, Lake of Dreams, Sea of Serenity, Marsh of Frogs, Ocean of Tempest, Death Lake, Sea of Humors, Putrefaction Marshes, Peninsula of Reveries. Sea of Tranquillity, etc., etc. They called the mountains, the Alps, Apennines, Carpathians. Famous men had imaginary abodes on the moon. On Mt. Aristotle was a city supposed to be peopled with peripatetic philosophers, who dwelled there after death, forever discussing syllogisms, propositions, and deepest problems of philosophy. In Plato's Circle lived his disciples, who spent eternity in study of prototype ideas. Thus they made the moon a heaven for deathless souls of our race.

Nothing is seen on the moon like the changes taking place on earth, whereon a thousand elements contend with each other. No tumultuous tempest, no hurricanes, no blizzards sweep over the plains, no wind blows, no

clouds rise, no storms sweep along, no trains of vapor or clouds are seen, no rain or snow fall, for there is absolutely no air. The sun rises and sets, lighting up the scenery with effulgent glory, brighter than ever sunlight reflected from earth's snows of frozen north. The shadows are extensively black so in them you can see nothing, for no air reflects and diffuses the sunlight. You are struck with what is called snow-blindness, but the light piercing and blinding you comes not from snow but from the brilliant white rocks. Even if you wore colored glasses soon you would be blinded with the glare.

Having no air there is no water, no fluid of any kind, for liquids can exist only under atmospheric pressure. If you put a vessel of water under a vacuum pump, and take out all the air, the water boils, soon evaporates and dissolves into vapor which fills the place occupied by the air. If once the moon had water it long ago disappeared to the last drop. Seas, lakes and rivers are only imaginary, the names were given in the times when men did not understand science.

The sky over our heads is blue because of the minute particles of matter floating in our atmosphere. But from the moon you would see no blue sky. All the sky is black seen from the moon. The eyes traverses a depthless immensity like a vault overhead without resting on any object. But at all times, day as well as night, you would see stars, planets, comets, nebula and the mighty Milky Way over your head. The sun marches among them with undiminished splendor, without blotting them out as he does on earth in day-time.

All is dark on high, all is silence below; no sound is ever heard, no sigh of wind, no rustle of foliage, no song of bird, no noise disturbs the everlasting silence. Intense repose broods over the solitude. All is death, the deep of the grave rests on the moon. There is a world which long ago passed from fierce fiery forces through

the vast periods of its activity till all its fires went out and now it is a dead world.

The vast plains of rock broken by fissures stretch out before you. The writer has seen the dead dry sandy plains of Arizona, the vast silent wastes of Arabia, the African Sahara, the dried up valleys of western America from Oregon to near the city of Mexico, but these are not as dry and dead as the plains of the moon. The photographs taken by the great instruments show the rocks stretching out, the mountains rising, and the details are brought out as though you were looking down at them from a few miles.

Tall, perpendicular mountains divide its surface, while here and there are craters of dead volcanoes with often deep saucer depressions many miles across encircling the volcanic cones. White rocks leap up like remains or ruins of long past volcanic revolutions; deep crevices cross and recross the stony plains looking like deep mud dried by solar heat after all the water has been evaporated. But these trenches are more than a mile wide and miles deep. They resemble in a way the great canyon of the Colorado with its pictured rocks—the mightiest trench in our earth in desert lands, 6,000 feet deep.

One is struck with the immense number of circular or craterlike formations all over her surface, found even in these places, falsely called "seas." We see them best along the borders of the sunlight, where they cast long, deep shadows over the landscape. They are of different size, some being many miles in diameter, while others test the highest powers of the great glass. Kepler thought they were built by reasonable beings. But better research forced astronomers to abandon this theory.

The smooth plains being darker, led men to suppose they were seas, lakes, bays and fens. They are often surrounded by high ranges of mountains, rising almost straight up like the wall of a house from the plains. The mountains of our earth have been acted on by rains, waters and the atmosphere, so the sides fell down. But

there being no air or water on the moon, these vast cliffs and mountains rise almost perpendicular, so nothing but a bird could reach their tops, if they were on earth.

Bright lines of matter, which better reflect the light, branch out from some great volcanoes, extending hundreds of miles. The surface of the moon cracked while it was cooling and this bright material was forced up to fill these great chasms. What it is we do not know, for as the moon does not shine with its own light, the spectroscope gives us a knowledge only of the materials in the sun, whose light the moon throws back to us.

A planet losing heat passes through different periods. The outside cools first and forms a crust. As the inside loses its heat it contracts, and the solid crust like a skin contracts and throws up ridges which make the mountains. When the melted matter in the interior becomes solid, just under this solid crust of rock it expands, as water in freezing, and throws out mountains through great cracks in the surface. In this way the mountains of the earth and moon were heaved up over the plains. But as the moon is much smaller than our earth it has not as many mountain ranges.

The greatest range of lunar mountains is the Apennines, having 3,000 peaks and stretching along 450 miles. Mt. Huyghens is 18,000 ft. high. Another range, the Caucasus, has peaks from 14,000 to 11,000 ft. The Alps has 700 lofty summits in two lines with a great straight valley 80 miles long, between. Isolated peaks are found scattered over many regions, the best known, Pico, being 7,000 ft. high, and 40 miles away is another 4,000 ft. The mountains are very steep, most of them could never be scaled by a living thing except a bird. Often they are like cones rising from the plains, and stand out harsh and rugged. They were made of the soft melted materials driven up through vents from the interior, and cooling built up the mountains as we see volcanoes thus formed on earth.

You ask how we can measure their height? By the

shadows they cast across the plains, for this is but a simple sum in figures.

The craters are round, some are high over the surface of the plains, some are below, all are like walled amphitheatres with steps inside and outside where the matter fell down while hot. Most of them, especially the larger ones, have one or more cones in or near their centers.

When greater powers of the glass are turned on the plains, they are seen to be rough and furrowed areas, gently undulating here and there, and broken into ridges, with now and then cracks or rents miles deep, and running for many miles like river beds. Craters of extinct volcanoes are scattered all over the plains, flashing out with varied tint and brightness, for the rocks are not all of the same color. One large sea has a greenish tint, others are pale red, and others nearly gray.

The mountains under the highest powers show a great variety. Some are in long ranges, and they have been called after famous mountain ranges of earth, some stand out as isolated peaks like cathedral spires, throwing long shadows in the setting sun, but all are without order. A fine telescope will reveal 3,000 mountains in one of the chains. We look down on them or sideways, as you would see a town from a balloon. But as they rival the Alps, the Andes, and the Himalayas in height, the scenes would be expressively grand if we could stand beside them and look up at their towering heights like walls of some gigantic and fantastic church towers.

On the lower side, that is near the southern pole, with naked eye you see a bright round spot with white streamers winding from it. That is Doerfel mountain, 26,691 feet high over the plain, and the bright bands stretching from it are ranges of mountains. Casatus is 22,800 feet Curtius is 21,954 feet and Newton 23,853 feet high. But there are many other peaks of almost equal height. We must remember these great mountains differ from those of earth, for they are all hollow, that is, they are

volcanoes, each with a mighty crater in the top often miles across and going down deep below the level plain. As you travel along the Northern Pacific Railroad you come to a great crater 10 miles across, like those of the moon. In this crater you find Butte, the city of mines. But no mountain or depression of earth shows the exact form and depth of those of the moon except on a small scale. Some of these depressions which once belched forth fire and melted rock are over 300 miles across, Ptolemy is 310 and Clavius is 403 miles in diameter.

Let us take one as a sample of the others. In the Sea of Rains, not far from the Caucasus, is Aristillus mountain, of which Lecouturier first gave a minute description. The crater is 24 miles in diameter. From the center rise two cones, the higher being 2,962 feet. The rim of the surrounding great crater is 10,324 feet high. When the sun shines down into the bottom of the deep crater, the telescope shows the bottom composed of hardened lava and blocks of great rocks like mountains heaped together.

Ranges of basaltic peaks ramify from this mountain as a center in five or six lines to the east and south, looking like multitudes of steeples and towers of a gothic cathedral. Along the railroad from Salt Lake City to Colorado on the north you will find a range of colored rocks, which on a small scale remind you of these ranges of mountains of the moon. Little changes are ever seen in the moon, for everything there seems dead, silent and motionless. But a French astronomer, carried away by what he saw, remarked to a marchioness:

"Everything is in continual motion, even including a certain young lady, who was seen in the moon with a telescope about forty years ago. She has considerably changed. She had a pretty good face, but her cheeks are now sunken, her nose is lengthened, her forehead and chin are now prominent to such an extent that all her charms have vanished, and I fear for her days." "What are you telling me now?" interrupted the mar-

chioness." "This is no jest. Astronomers saw in the moon a particular form, which had the aspect of a woman's head, which came out from between the rocks. Then came some changes in this region. Some pieces of the mountain fell and disclosed three points, which could only serve to compose a forehead, a nose and an old woman's chin." Often we see rocks forming human figures, a face and head, and such a figure was seen in the mountains of the moon which changed because some of the rocks fell. This is about the only fall of materials recorded, and such things take place very rarely. During a hundred years, every day of which the face of the moon has been observed by some one, not another change has been seen.

The bright streaks radiating from some of the volcanoes, especially from Tycho, do not rise above the surface of the landscape, and as they pass through mountain ranges, they were caused by whiter matters thrown up through deep cracks or fissures. They look as though some giant brush had plashed the surface with a whitish pigment, or calcimined in straight lines for more than a hundred miles. This white material is found within, on, and for a certain distance round craters and mountains, giving white brilliant effects to these regions, while the plains are of grayish darker rock. This is the cause of the bright and dark regions of the moon. A small crater called Linne, a little more than a mile across, is very white; some thought it an active volcano. But more careful study showed the true cause of its whiteness.

It is evident that after the crust of the planet cooled, the expansion of the materials within as they lost their heat burst the crust, and this white matter exuded through the cracks. Astronomers took many glass globes filed with water, and ceiling them up, placed them in hot water. As the water within expanded with the heat, the globes burst into long slivers of glass resembling in a remarkable way the white streaks on the moon.

Draper first made a photograph of the moon, and since that time the more exact photo has taken the place of the old map. Craters to the number of 229 have been named, mostly after famous astronomers. We will describe some of the most prominent.

Below the middle and to your right shines out a bright spot even seen by the naked eye, having below and to the west a long range of mountains called the Apennines. This is Copernicus, 46 miles in diameter, the grandest and most striking object of the lunar surface. It is a vast extinct volcano, with ramparts rising 12,000 feet above the level of the surrounding plain, having nearly in the center of the depression some great cones, three of which rise to the height of 2,400 feet.

The round ramparts are divided by concentric ridges, terraced, showing how the hot melted rock fell in and out, crushed by the overloaded masses of the high summits. Ranges of mountains radiate away from this giant volcano, especially north and south. Impressive and sublime is the grandeur of this scene, which transcends every mountain scenery of earth. Only by looking at it through a telescope can the mind gain any idea of the awful forces which once sported here. We can give but a faint description to one who has not seen it. But it is only one of hundreds of such objects, showing how vast and wonderful in might were the forces which made the worlds.

Copernicus was caused by a tremendous discharge of melted rock, lava, scoria and fire ages ago, when our satellite was cooling. For more than 100 miles on all sides are smaller craters, their round edges rising over the plain with deep cracks, a mile or more wide, extending down into the rocks perhaps for miles; but we cannot see the bottom of the crags in the inky black shadows. Bright streaks radiate on every side, showing that the bright, white melted matter of the interior oozed out and filled the chasms. They radiate and cross, and seem to have been formed by contraction in cooling, as ice cracks

with intense cold after it has formed on water of our lakes. All around and mingling with the smaller craters are cones as high, round steep hills, showing where the melted matter was thrown up and became solid mountains, the sides steep almost as the side of a building, ending sometimes in a round hole in the top.

The bright spot you see with the naked eye with streaks radiating out from it as a center, and which looks like a very white round spot—the most striking thing on the moon, is Tycho, called after the famous astronomer. The surface of the moon cracked from this spot, and the white matter within came out filling the mighty canyons, which extend from it almost half across the surface of the planet. Some are 1,000 miles long.

Tycho is 54 miles across, and more than 16,000 feet deep. From the center of the crater rises a cone 5,000 feet high. The round ridges of concentric formations, both on the inside and outside, like gigantic steps or terraces, show how the rocks, half-melted, fell down causing landslides of which we have nothing on earth to compare to them.

On every side for many miles round Tycho are smaller craters with round edges, some half the size of the giant cup-like depressions in their midst. Wild is the desolation of tremendous crater mountains and ridges showing this region served as the great safety valve when the planet was disrupted. The fiery forces and upheavals, which took place here were on a most tremendous scale. As the sunlight illumines the tops of the round mountain ranges inclosing the crators, and steals down into the round mighty inclosures, lighting up the scenes, it is a most impressive sight. Peak after peak, ridge after ridge, cones after cones come out of the black darkness, and shine with dazzling brilliancy. You see the white glistening rocks on one side of the round mountain sides, while the other side is dark as midnight. Your eye tires, your mind is stupefied, your imagination is lost at the diversity, as you try to look at once at so many things.

But above all you are moved with the utter scene of desolation. Nothing is found but bare rocks round ranges of mountains inclosing deep areas below the surface of the plains, which hardly appear, the surfaces are all covered with remains of former volcanic activities.

Herschel in his observatory at Cape of Good Hope often saw the moon sink below the sandstone surface of Table Mountain, both illumined at the same time with sunlight, and he says the moon at such times was "scarcely distinguishable from the rock in apparent contact with it." We see nothing on the moon but rock; there is no sand, or soil, for it has no air, and no rains or floods ever washed its surface.

Seen through a telescope it has a yellowish-white color among the mountains, but this color is dimmer on the plains. The plains, called Mare Humorum, Mare Serenetatis and Mare Crisium show a somewhat greenish tint, but this does not come from vegetation, but from the color of the rocks. We have seen lava which recently flowed from a volcano of bright green and red, glistening like glass before the tints were dimmed by the atmosphere. This is the case with the matter ejected by the volcanoes of the moon. We are too far away to see the varied tints of these colors as we can with volcanic rocks on earth.

Could a man live on the moon if by any way he could go there? It has absolutely no air, water, vegetation,—no life of any kind. Its surface is a vast desert of rock, plain and mountain. We will not go into the long and careful examinations learned men went through before coming to this conclusion. If it had any water at any time, the long 700 hours of each month of brilliant sunshine would long ago have dried it all up. The old astronomers imagined they saw seas on its surface, but larger telescopes show them to be nothing but great plains of rock. While the sun shines on one side, the heat is 300 degrees above zero and on the other dark side it is

200 degrees below zero F. Nothing could live during such monthly changes of weather.

From earliest days the moon has been used as a guide by those who go down to sea in ships. England depending on its shipping offered a $100,000 prize to the one who would make a machine which would keep nearly perfect time at sea. John Harrison made the chronometer and gained the prize. Like our watches, it has a heavy balance wheel swinging back and forth free, to move like a planet in its orbit, but like all man's works it is imperfect, and many chronometers are carried on war vessels. With an instrument they take the position of the moon, and in the Nautical Almanac tables they find her movements, and a little figuring gives the longitude of the ship and its distance from port. Jupiter's satellites are often used, and observations of other planets and stars may be depended on, but the moon is the great guide of seamen.

We look over histories and find eclipses of the moon mentioned. We figure back the movements of our satellite and thus fix the exact dates of these events to the very hour and minute. We would know little of the surface of the sun if the moon did not come between us and the king of day. At a total eclipse of the sun, we can see the vast fires which rage on the solar surfaces. But many superstitions regarding the influence of the moon on the weather rose in time long past. But we find that its influence on our atmosphere is almost nothing.

We look on the moon mostly as the "lesser light" to shine at night. But it is the greatest health-giving and sanitary agent. Rest and stagnation breed disease in waters of the earth. But the attraction of the moon for these waters causes movements, flows and tides. But the moon's attraction for the air has also its part to play in winds and atmospheric changes.

Rivers pour into the oceans millions of tons of decayed matters, which if left near their mouths would fester and fill the air with deadly disease germs. But

twice a day the tides sweep these decomposing organic matters away out into deep ocean depths, where the salt waters kill the germs. If it were not for the tides raised by the moon our rivers and harbors, into which the sewers of our cities empty, would soon fill with festering products, rendering navigation impossible, and breeding such pestilences that we could not live near the mouth of any river. But the tides come in and raise up the waters. At Liverpool the tides rise about 30 ft. When the tide goes out all this harmful matter is driven out to sea, and the next tide brings in the clean ocean waters. Thus Providence has foreseen how with the moon's attraction to guard our health.

When vessels want to move from one place to another they take advantage of the flow of the tides, and this vast mechanical work is done by the moon. This amount of work done by the tides in London harbor is estimated to amount each year to more than $5,000,000. It is nearly as great in New York harbor, with the hundreds of miles of its deep-water shores. Let the reader imagine the amount of work the tides perform in all the waterways of the world, the ocean tides, the Gulf Stream, etc., and he will see how useful is the moon to man.

But we have hardly touched the vast storehouse of power our satellite exerts on earth. Long ago, before man was made, a vast and varied vegetation lived on earth. It changed sunlight and heat into growth of plants. Then came floods sweeping over the surface of our planet. There was a Gulf Stream of tremendous size which flowed from South America over the plains of the Mississippi Valley where it turned towards the east. From these tropical, hot regions, covered with a great flora of trees and vegetables, it brought in the bosom of its vast flood miles deep of vegetation, and landed them along the plains of our country. As the waters swept over the Apalachian range, they tumbled them into the valleys, then covered them up where now they are found as coal.

But the time will come when the coal will be all used, and what will we do then for light, heat, fire and movement of machinery? Light, heat, and motion are but different kinds of movement. We can then use the tides along our coasts, and transmit the power to our homes and cities. The lift of the water during the tides is small, has hardly been used, but the power going to waste is stupendous. This can be sent out as electricity or compressed air. Thus God has foreseen and provided for us a satellite, with its stored up power to be used when other means fail on earth.

SECTION III.—THE WONDERS OF THE EARTH.

CHAPTER X.—ARE THE STARS INHABITED?

From Fontenelle to Proctor many writers held that the millions of suns must have planets revolving round them, similar to the planets of our solar system. Every little while sensational articles are published in newspapers and magazines stating discoveries show that people live on Mars, or some other heavenly body. In the last century men were supposed to live on the moon, but the moon was abandoned as unfit for life, when better studies of our satellite show she has no air or water, is a desert waste of rocky plain and mountains on which nothing could live.

But the question is often asked: Have the other suns planets? If they have, do plants, animals or men like us live there? Do not some other kinds of people of a lower or higher order of intelligence inhabit these millions of orbs?

In "Worlds of Space" Mr. Gore considers the mass, temperature, rotation, atmosphere and water required on an orb that it may support life. He estimates there are ten millions of yellow suns like ours. If one in ten has the right conditions of light, heat, etc., to sustain life, there will be a million suns which could support life, if they have planets. But all this is pure speculation. There are absolutely no proofs, not even hints, that any sun except ours has planets. The bodies revolving round these suns, are suns themselves hotter, as hot, or cooler than the primary round which they gyrate.

To solve the question regarding living beings on

stars and planets, we must weigh well four questions —their heat, mass, density and atmosphere. The heat of our sun makes its light yellow, while the heat of the other suns varies so they shine with purple, white, blue, green, red or dim lights. These colored lights would not support life. On the contrary, living beings can live only in the light of a yellow sun. We know how the X-rays will burn the flesh, and the light of the colored suns would be more harmful.

The life of our sun has been just long enough to sustain life on earth. The duration of the light and heat of the sun depends on its mass and the heights from which its materials have fallen to it to cause its heat. Suns smaller than ours have lost much of their light and heat, without which life is impossible on any of their planets. For life depends on light, heat, water, atmosphere, and on a thousand nicely balanced conditions.

The Milky Way, with its millions of suns thickly studded over its whole area, is in a condition of enormous energy—heat, light and electricity with vast forces play within its boundaries, and on its suns. New stars there appear, all the time showing that collisions of suns take place giving out such changing heat and light that they appear and disappear. We see them as their light sweeps across the tremendous distances which separate them from us—even if that light takes 1,800 years to come to us. No living organism could exist in any region where such forces play. For the Milky Way is the theater of extreme activity and motion. It is crowded with matter under continual change, and is unstable for any length of time. If life were created on any planet revolving round one of the suns there, it could not exist.

The only place in the heavens where life could exist is within the center or hub of the Milky Way, far removed from the indescribable changes, from the tremendous upheavals of light, and heat, and collisions in that great belt of hundreds of millions of

suns. Within this Milky Way, about in its center, is a cluster of stars formed of a few thousand suns of which our sun is one. Here matter is more or less fixed and stable. The orbs within this space have passed through their vast cycles of changes; they revolve round their primaries without collisions, and they do not come near enough to each other to cause ruptures of their masses. Professor Newcomb with others concludes that the stars of this inner solar cluster have much smaller masses than our sun in proportion to the light they give, and that the brighter stars are much less dense than the sun. Therefore they cannot continue to give out light and heat for as long a period as our sun. For these reasons suns similar to ours are very limited in number.

Even regarding suns just like ours, only for a part of their duration could they give the right amount of light and heat to support living organisms on their planets. For, while they were forming by matters falling on to their surface, they would give out a light and heat which would kill all living beings. They change their light from time to time—most of them are variable stars and we see through the telescope these catastrophic outbursts when larger masses than usual are drawn to them. All these stars of changeable light must be left out as life-sustaining suns. The suns then which may have revolving planets on which life could exist are very limited. For only after a sun has received nearly all the matter which will fall into it—that is, has attained its maximum and begins to cool—can it give the gentle, unchanged, sustained and continued light and heat required for life.

But when we examine more closely these few yellow stars which resemble our sun, we find nearly all are double. The most powerful telescope shows them as single shining bodies. But the spectroscope tells us that they are double, triple, and sometimes there are four or many stars—all revolving round each other. It is evident that these have no planets, for they would

smash against the other bodies. Even if they had, the light and heat would be too great for life, or the planet would have to be so far away as to receive too little light and heat for living things. There are so many of the double stars, and new ones are being found every year, that Professor Campbell of the Lick Observatory states, that as our instruments are improved, these discoveries will go on "till the star that is not a spectroscopic binary, will prove to be the rare exception." This is the opinion also of other eminent astronomers.

It is certain that life could not exist on any of the suns which give out intense light and heat, for they are a thousand times hotter than melted iron. The tides on a planet near them would be enormous, and of great irregularity because of the attraction of two or more suns around which it revolved. A vast number of stars therefore must be put aside as the residence of living beings. As science advanced, one star after another was found unfit to sustain life, even if we were sure any of them had planets. This leaves our sun and two or three other suns like him fit to sustain life on their planets.

But even regarding these few suns, we do not know that they have any planets. Even if they have, we cannot say that these orbs may be just right, just near enough, too near, too far away, or that they have land, and water, and atmosphere, and the thousand conditions required for life. All is guesswork and wild theory. When the matter is all sifted, it will be found that of all the hundreds of millions of suns, ours alone was made with the conditions of mass, age, materials, light, heat and electricity, balanced just right to sustain the living organisms of earth. When we examine the sun's planets, of which our earth is one, we find that this world alone has all the wonderfully created and developed conditions for the support of life.

In making stars, suns and planets, therefore, Wisdom looked far ahead, created the right amount of matter, in the right place, and gave it laws to direct

it while condensing into this world, into these planets, and into the sun. In the spaces within the solar system He made the gases—oxygen, hydrogen, nitrogen, carbon, the light aluminum, the heavy iron, the chlorides and many other minerals. These condensed, made this little world among the many million orbs with all its varied materials. He watched it forming of dust, gases and vapors, guarded it while these condensed from vapors into liquids, and at last became solids. He upheld its laws. A thousand changes might have happened which would upset the plans. But at last the time came when all was ready, then its seas swarmed with life, its surface was covered with plants, its hills and plains supported animals. When all was ready, he said: "Let us make man to our own image and likeness," and man appeared on earth alone of all the heavenly orbs. A man weighing 140 pounds on the earth would weigh 23 on the moon, 53 on Mars, 371 on Jupiter, 123 on Neptune and on the sun nearly 4,000 pounds.

The way earth's poles are inclined in relation to our planet's path round the sun, which causes the variations of the seasons, is the most favorable for living beings, and any other inclination of her axis would soon kill them. The seasons, as well as day and night, are required for the life and development of plants, which thrive in summer and sleep in winter. Trees and plants which shed their leaves in the fall and bud in spring, will not live when transplanted to regions under the equator, nor can we get plants taken from hot climates to grow in our temperate zones. Few animals will live if taken from the regions where they belong. The domestic animals, made for man's benefit, flourish in different climates better than wild animals, for they were made to be man's dumb servants, therefore they can better stand a change of climate. The dog, tamest animal which lives, follows man from the equator even to the far north, almost to the poles. We do not think the dog was ever wild, like wolf or

fox, to which species he is related, that man tamed him. He was from the beginning man's most faithful friend —tame as he is now, made for that reason to stand all climates, for taming him would not change his nature.

For short terms men have endured 97 deg. F. below zero and 154 above. Dogs can stand this cold, but it is doubtful if they could endure this heat, because they have no sweat pores, for they perspire only through the mucous membrane covering mouth and air passages. A man's system can stand what would kill any animal, for he is the most perfect animal.

The whirling world makes day and night so necessary for the nobler animals which demand rest and sleep. Their very natures require sleep each 24 hours. Rhythmic movements of varied kind, degree and length, almost like music's harmony, take their turn, all agreeing with day and night the rotating earth produces. We work with mind or muscle; activity and rest, growth, decay, nutrition and waste, go always on. We cannot stay at the same thing always, a diversity of work pleases best. We cannot work all the time like angels; we tire, we weary towards night, darkness comes, when relieved of light's stimulations we sink to sleep in that period of repose our Creator gave when he made the world go round once a day to agree with our demands for rest, and not like revolutions of other planets.

A million things we will not stop to tell, sing songs silent yet eloquent in harmonies built on mathematics —they are ever chanting, all nature proclaims the glories of the Almighty who built the universe as a weak image of Him unseen. We are so ignorant of science, so stupid, so buried in material things, so busy with life's labors, so occupied getting a living, so hungry for money, we do not read the lessons the Eternal gives us day by day in His great book of nature.

How blest is balmy sleep! We do not sleep enough, nothing can take its place, without it would come

awful sufferings—insanity about the 8th day, and death the 10th. If we do not sleep regularly each 24 hours the world turns on its axis we cannot do good work. No one ever sleeps too much. For he is in sleep ruled by nature's laws alone, then he does not think and nature makes no mistakes. It is a mistake to waken one from sleep without a cause. No one in good health will ever oversleep. Some get along with more, some with less, but the average for literary people seems to be from 9 to 10 hours, yet many go through life with 8 hours sleep.

You cannot skip a period of 24 hours every second day or interrupt the order of man's nature the Creator planned.

Few understand the necessity of sleep or what weakness and troubles and anxieties are caused by want of rest. A woman of the writer's congregation, left a widow, slept only every second night. She worked continually for 36 hours against the writer's vehement protests, saying she was very strong and had to support her children. She died within six months. Her sister took her place, laboring the same way, and lived five months.

In daytime, light, as a stimulant, rouses us to labor, and darkness soothes us to rest in nature's "sweet restorer, balmy sleep." When we sit or lie our muscles rest. But while awake we always think, drawing from the nervous system images or forms from which the mind gets its ideas. But when we sleep the nervous system is at rest. We can labor or think only for a certain period, and good health and work of mind or muscle require rest every 24 hours, at least; for otherwise we cannot do good work. The earth revolves on its axis every 24 hours, causing day in which to work and night in which to sleep. Who caused the world to revolve in this time which agrees with the periods of work and rest? Did this happen by chance?

Plants and animals also demand these periods of work and rest in places where they are regular, as under

and near the equator. These plants or animals will not grow or flourish except under these conditions of day and night. In the cold arctic regions, where days and nights are sometimes six months long, these plants and animals of warmer climes cannot live. But the plants which live there grow with great activity during the long six months.

Five conditions are required for organisms—plants, animals, and men, and these are found on no star or planet except our earth. 1. A regular continued heat-supply, within a limited range of temperature. 2. A sufficient supply of heat and light of a sun. 3. Water in great abundance, and distributed everywhere. 4. A dense atmosphere formed of gases present in suitable proportions. 5. Alternating day and night. If any of these conditions are absent all organisms would die.

Creatures can live only in a temperature between freezing water, 32° F. and 104° F. For nitrogen and its compounds between these temperatures only, have pecularities essential to life—extreme sensitive mobility, facility of chemical change exerted in tearing down and building up the living organisms. Water, which enters so largely into all living organisms, at the freezing point becomes solid ice and then the functions of life are interrupted. When a member is frozen it dies, has to be amputated, or its dead materials would be taken up into the circulation by the blood and poison the organism.

When the weather is very warm, man, animal, and plant suffer, and if the heat rises too high they die. But God has provided against injury. The skin opens its pores and bathes the members with water mixed with worn-out portions of the system. This water as perspiration evaporates rapidly in the heat. As water turns to vapor it requires heat and absorbs the heat of the body, thus cooling the system down below the danger point. It is wonderful how the organism knows how to cool itself this way, that it would make use of this cooling process of evaporation ages before

man discovered it in the study of heat. We might cite the wonderful ways animals sweat, but we will cite only the case of the dog. He has no sweat pores, and by instinct he sticks out his tongue and pants, for he perspires through his epithelium, covering mouth, tongue and air passages.

A very small increase or decrease of temperature would destroy all life on earth. For albumen found almost in a pure state in the white of eggs, one of the proteids composes the greater part of the animal and plant organism. It becomes hard and white by heat at about 160° F. You see that in the cooked egg, a heat of this degree would cook solid all the albumen of every living organism on earth and kill every plant, animal, and man. Alcohol also cooks this albumen. When a man drinks liquor the alcohol coagulates his nerves, so he cannot reason rightly. He becomes first roused to renewed activity, feels warm, but the feeling is a deception. Men who go to the far north where they endure extreme cold never drink, for that would weaken the system, numb the nerves so they would not be able to withstand the cold, and they could not carry on their work. When men drink deeply and for a long time, their nerves are so profoundly disturbed they are subject to delusions, blame others for all kinds of imaginary injuries, and at last they think they see "snakes," etc. Liquors are slow but deadly poisons—the scourge of modern days and carry off more victims than all wars, famines and pestilences.

These extreme sensibilities of life to changes of heat and cold are caused by the instability of protoplasm, the foundation of all organisms, and of the proteids entering into their formation. For generation, growth and nutrition depend on the continued motion of fluids, combinations and decompositions going on regularly, which heat or cold of extreme degrees stop. Nearly all plants and animals must have a certain and continued heat to live. Man, alone made for the wide world, is the only exception, for he can live in tem-

peratures which would kill most plants and animals. To him alone was said, "Fill the earth, and subdue it, and rule over the fishes of the sea, and the fowls of the air, and the beasts and the whole earth." Gen. i. 26. Man alone of all animals can live in the hottest as well as coldest climates all his life.

Extreme heat and cold do not always last. Seasons come and go, the climate changes from day to day, and month to month. No land animal passes his whole life where the temperature remains above freezing. No part of our earth is always in midnight darkness for then ordinary plants would not grow because they cannot without light. Without plants animals would have nothing to eat, because no animal can make protoplasm out of the minerals, they must get it from the plants. The plant alone can take the carbon from the air, seize with it other elementary materials, and with it build up the wonderful compounds required in its system, and which it furnishes the animal in the shape of food. All this the plant does with the aid of sunlight, and with special rays of this light. Only the light of a yellow sun furnishes these rays used in growth. If our sun had any other color, all life would soon disappear from our planet. We doubt if any of the millions of suns as the spectroscope shows their light colored would sustain life on earth if one were transported to take the place of our sun. Is there not a wonderful provision here. Who made our sun as we find it, and then made life on our earth to live in its light, and not in the light of any other of the millions of suns?

Suppose our sun was larger, that it had the size of the thousands of suns much larger—if it was as large as Arcturus our earth would be burned, exposed to a fiery surface. All the materials of the world would be in a state of metallic vapor because of the tremendous heat. Let us imagine that our sun was twice as large as it is, every rock and mountain, even the solid crust of earth would almost melt with the heat.

Nothing living could exist on our planet. If the sun was half its size, eternal frost would reign on earth. Again, we will suppose the sun not as hot or hotter than it is, then nothing could live. Our sun gives out just that light and heat required for things to live in, just the proportion wanted for life functions. If we apply the rules of probabilities to these questions, we are lost in figures showing design in nature, and mathematics prove that a Cause having reason arranged all these things, that life might exist on earth.

A man will survive sickness or wounds which would kill any animal, because he has the most highly developed organism. A healthy man with sufficient food keeps his temperature within one or two degrees, even when the heat is 170 deg. above or 75 deg. below zero. Heat which kills every organism will not destroy human life. Nature knows this. When microscopic plants or animals enter the human body they grow rapidly, the heat increases to kill them, and we say he has a fever. When the bacillus coma, the cause of consumption, or phthisis pulminaris gets into the lungs or any part of the body, the temperature rises to kill them. That is the reason people afflicted with this dread disease are so hot. But if the temperature rises to 104° F. there is danger, while if it rises to 106° and continues at that figure for a long time the heat causes such changes in the body that death follows. Who made the organism with instinct to know that heat kills these invading and rapidly propagating microscopic organisms?

But that is not all. In the blood float millions of little white round bodies called the white corpuscles of the blood. These attack, surround and destroy any disease germ they find in the blood. They are called leucocytes, "white devourers." But they will not eat up these invading hosts which cause fevers and death unless they have plenty of a sauce, a fluid of the blood, called opsonin, "feast-preparer." Without going deeper into the matter, we will say these are the rea-

sons strong healthy people survive diseases and fevers which kill weak persons.

Consider the even temperature of our earth, and then think of the awful heat of the fixed stars, as well as the frozen moon, and great changes of light and heat of the planets. Seeds will germinate in dry heat only at a certain point, but will not grow at a temperature above 150° F. or at 4° or 5° above zero. Within these degrees all life flourishes on our planet and above or below them nothing could live. Who fixed the temperature of our earth between these two extremes, but that infinite Mind who shaped things from the beginning?

The normal heat of the human body is about 98° F., and this is maintained within one or two degrees though the heat of the atmosphere may be more than 50° F. below the freezing point, or 130° F. above. Under the tropics, the mercury seldom rises to more than 96° F. in the shade, but it rises to 110° to 115°, in the Sahara, and 120° F. in Australia and parts of India. The writer suffered most from the heat in the Sacramento Valley in California, along the vast deserts of the awful Sahara in Africa, and in the deserts of Arabia. The heat of the deep valley of the Dead Sea, 1,300 feet below sea level is awful during summer months. The writer passed a night in Jericho in April, the heat was so great, the whole bed became as it were saturated with perspiration, which soaked down through the two mattresses and dripped on the floor. While for the most part animals can live only in certain parts of the world because of extremes of heat and cold as well as for want of food, man, made to fill the whole earth, can stand extremes which would kill most animals. Who will say Wisdom infinitely wise and powerful did not tilt over the earth so it hangs at 23.5°, as it swings round the sun causing winter, summer, and the seasons each year?

Who will hold that no Cause modified heat and cold so men might live on nearly all parts of its surface ?

The materials of the planets were formed in about the same places in the universe, but the greater mass of the earth held all the air when the worlds were made. Dr. Johnstone Story figured out that the moon cannot hold even carbon disulphide or carbonic gas, both being heavier than air. As its mass is only one eightieth that of the earth, no oxygen, nitrogen, hydrogen or water could remain on the moon. Was it an accident then that our earth has the right size and mass, just enough to hold in its attraction these gases which uniting make air and water?

Gases in larger or smaller quantities float between the stars, we see some of these bodies as comets. They may pass near the moon to condense into liquids on its surface, but the heat of the sun is so fierce there on the moon's illuminated surface they would soon become gases and escape. What would happen if a great body of these gases met the earth in its flight through space? If great quantities of hydrogen and oxygen fell on earth they would unite in an awful explosion as water in our higher atmosphere, and fall as mighty floods drowning our world. The ancient Babylonians have a tradition that in this way the deluge came in days of Noe.

A planet a quarter the mass of earth would retain water in a state of water vapor, steam, which falls as rain to sustain life. But such a little world could not hold by its attraction the other gases required for living beings. For these reasons no life can exist on the small moons of the great planets, nor on the asteroids. A planet must be about the size of our earth to have inhabitants. Hydrogen is produced in small quantities by volcanoes and decaying vegetation, but is hardly ever found free in our air. It is so light it is often used in balloons, but the general idea is that it escapes from earth's high regions into interstellar spaces. With oxygen it forms all the water on earth; the amount is vast, yet if a tenth more hydrogen were created, nearly all the land surface would be covered

with water. What an adjustment was made at creation so there is just enough water to fill the oceans so full, and leave enough land for the development of life. Do you think this was caused by chance or an accident?

These adjustments and balances strike us on every side. Here we live on a planet one of the latest formed in the tremendous eons of ages of the heavenly bodies, a world unique in the solar system. It has enormously deep oceans filled with salt water. These ocean depressions are placed with regard to the equator just right for ocean circulation to distribute heat. Just enough oxygen, hydrogen and nitrogen were made to fill these oceans, and make the air a hundred miles high. A thousand combinations of materials and gases, and fluids are ruled by laws which began to regulate things millions and billions of years before life appeared, and these work on, all are so wonderfully poised, that if the slightest change took place all life would cease. Who says these things were brought about by accidents?

The mass of the earth is just right to bring about these conditions favorable for life. If our earth were a little larger, or denser, no life would be possible. If in place of being about 8,000 it were 9,500 miles in diameter, a difference not much when compared to larger planets, it would be two thirds greater in bulk, have a greater size and density, all things would be twice as heavy, and it would have retained about twice as much air and water. No hydrogen would be retained, but the surface of the earth would be one half greater, and the whole earth would be covered with water miles deep. Did an accident regulate its mass and size?

If we look at the other planets, we see the relations of size and mass to conditions of life. The smaller planets, as Mercury and Mars, have not enough mass and gravity to retain enough water in a state of vapor, without which life cannot exist on them. For water

vapor to cause rain must be diffused through the air as on earth. The larger planets have such small densities compared to their mass, there is no solid rock or soil on them. Saturn, Jupiter, Neptune and Uranus are so hot that all materials of which they are composed are in a melted or vapor state. You might as well look for living organisms in a furnace of melted iron as on them.

Light and heat, as well as water, are conditions required for life development, and these must be found in most regular and nice conditions. Slight changes one way or another the world could not be inhabited.

The conclusion forced on any one who examines these questions is, that of all the millions of suns and planets this world alone has the conditions beautifully balanced by a Creator infinitely wise to support life. This world alone is inhabited. There is only one human race. All these stories of life and inhabitants on other heavenly bodies are simply the products of the imagination, and rest on no solid scientific principles or discoveries.

Except a few dwarf plants and peculiar beasts made to survive cold in polar regions, life in the universe is confined to a belt round the earth rising from her surface at the arctic circle, getting higher and higher, till over New York it is 12,000 feet, high over the equator about 20,000 feet, continuing south it gets lower and lower till it strikes the earth's surface at the antarctic circle. Our little world, carrying its precious freight of living organisms, sweeps its yearly path measuring 560,000,000 miles, at the rate of 19 miles a second, round the sun, 332,000 times greater, at the same time whirling at the equator from west to east 1,440 feet a second; these two rapid movements the Creator gave it, we never feel, for we float in ether filling star spaces.

CHAPTER XI.—THE BEGINNINGS OF THE SCIENCE OF THE STARS.

Science began in Babylonia, where the 72 families born of Noe's grandsons lived before they separated to found the nations of antiquity. Ham's grandson Nimrod: "Let us rebell," or "the Rebel," a powerful chief, founder of the Babylonian empire, taught this world is God appearing to us, the natural forces are gods, the sky a crystal sphere revolves each day carrying the stars round the earth, their fathers, the patriarchs, after death went to heaven and became the planets and thus founded pantheism, "all is God," which developed into paganism with its numerous gods. In tradition, song and story, Nimrod came down as Hercules, Jupiter, Thor—chief of the gods.

To escape another flood, at Borsippa he induced them to build a tower to reach the solid crystal sphere up in the sky, where God lives, whom they named Il, the "Mighty One," and Hebrews named El. They called the tower B—Bab-Il "Gate of the Mighty One." Twelve miles away, on the banks of the Euphrates, they founded their capital—Babylon "City of the Gate of the Mighty One." Later Hebrews called the tower Babel, "Confusion," for there the original language of mankind was changed.

Supposing the horizon upheld the solid crystal sky, later they named the rock of Gibraltar and the Atlas mountains the "Pillars of Hercules," and the fabled Atlas upholding the world. In Egypt they supposed four mountains sustained the sky, when they were shaken rain fell, and many peculiar scientific errors came down among the nations.

Science and religion went hand in hand, the Babylonian priests being the first scientists. In every

Babylonian city rose a vast pyramid with seven great steps, each smaller than the lower, the sides colored to represent the seven planets. A step, typical of the sun, was covered with gold plates, another, emblematic of the moon, was of silver, a red one represented Mars, etc. The temple shrine crowned the top, where the priest-astronomers observed and worshiped the stars.

Down from creation came legends that the original man came from God, and the king was the heir of a part of Adam's authority. When the tribes spread from Babylonia to colonize the nations, they brought with them the idea that the king descended from the Almighty.

Only a king could build a pyramid, in which he and members of his family were buried. For this reason pyramids are found along the Nile Valley, in parts of America and in other countries. These vast buildings are found in great numbers in Egypt. The best known are the three across the Nile opposite Cairo. Few know the reason they were built. There were the three cemeteries of kings and nobles of Memphis, about 12 miles to the south. We wandered through the ruins of this city mostly built of sun-dried bricks, the little houses with roofs fallen in, walls still stand, since the time the Persians ruined the city 3,000 years before Christ.

The kings of the 4th dynasty built these pyramids in the three adjoining cemeteries. The members of the royal family were buried, not in the low stone monuments as were the nobles, but in a monument like those pyramids of Babylonia which served as observatories. The largest, that of Cheops, standing out from the brow of the hills, is the greatest monument man ever built to the soul's immortality. The Moslems took away 20 feet of the stones on each side to build Cairo, but still it stands 480 ft. high, a vast pile with stone steps. We went up about 150 ft. then down the passage and up into the Kings' Chamber. We climbed to the top and surveyed the scene of death—the Sahara desert stretching far out to the west with the Nile below to

the east. The observatory, at the top, long ago disappeared. They placed the mighty structure, with sides at the exact points of the compass.

Professor Smyth, the Scottish royal astronomer, wrote a book on the pyramid of Cheops, to prove the Egyptians had a remarkable knowledge of astronomy. He holds it was built as an observatory, that it contains all the elements of earth and star measurements, that it was built when the fixed star A. Dragon in its upper course was visible both day and night from the bottom of the long passage, inclined at 45 degrees, going down as a blind to the rock chamber under the foundations of the pyramid to mislead any one seeking the body of the dead Pharaoh embalmed and laid to rest in the stone coffin in the massive "King's Chamber" high up, approached by a magnificent marble carved passage, also at 45 degrees in the middle of the massive structure.

This would show this pyramid was built in the year 2,170 before Christ, when the Pleiades began at the point of right ascension in the great round of the circle of the equinoxes which takes 25,868 years. Smyth's book makes very interesting reading. But it seems improbable the ancients had such an exact knowledge of the sun's distance, the earth's size and many other discoveries of our day found only after most careful and deep figuring in the higher mathematics, which were only discovered in our time.

The Chinese emperor Chwen-hio adopted as an epoch from which to reckon dates the conjunction of Mercury, Mars, Jupiter and Saturn, which took place 2,449 B. C. But it is shown that the instruments now used in China were introduced by the missionaries. In very early times they could foretell an eclipse, for we read that the emperor Chow-kang in 2,169 executed his astronomers Ho and Hi for not foretelling an eclipse.

The study of the stars fascinated all races in their infancy. Many Egyptian temples built between 2,200 and 1,500 B. C., have their long axes so placed the longest day of the year the light of the sun shone at

his rising or setting through the long line of narrow doorways, to light the dim holy of holies, at the farthest end of the sacred fane. Temples were built so the sun, moon or a particular star shone into the sanctuary each time the heavenly body passed across the meridian of the temple. Egypt is a gift of the Nile, which flows through a deep valley of the Sahara sands. Without the river water nothing would grow. The revolutions of the sun they thought regulated the rise and fall of Nile waters, therefore it was of national importance to fix the calendar points of the compass, rising and setting of sun, moon and stars, the longest and shortest days, for the light and heat of the sun made things grow. A tradition came down that God made man, they supposed the sun was the Creator, and the Pharaoh, "son of the sun," bore part of Adam's authority to rule the nation.

Every Egyptian king being high priest of the nation, built, restored or repaired one or more temples, and the Ptolemies and Cæsars followed the same custom. These temples were all built on the same ground plan. A sanctuary, or holy of holies, inclosed on three sides by smaller rooms, communicated with a corridor on the fourth side facing the axis of the building. Then came an inner court, the hypostyle, "with roof supported by many columns." This inner court was sometimes separated from the sanctuary by a pylon door, or screen with gate towers, one each side the entrance. An outer court with a pylon entrance completed the main edifice. The whole building formed a parallelogram with side walls which had no windows, and was entered only through the gate, which was the main door between two great gate towers, rows of obelisks on either side led up to this. Except the holy of holies and its approaches, the whole temple was open to the sky, for it hardly ever rains in Egypt, and the climate is mild the whole year.

The Egyptians were good astronomers and knew the years were 365 days. The records Moses left in his

history of the Hebrews leaving Egypt, and later discoveries prove these facts. A ray of light from the sun or a star entered and passed along the axis of the temple, and marked the instant of the solstices, equal days and nights, twice a year to the very second for 1,000 years. The axis of the temple was like a giant telescope, and the beam of light fell on the rear wall of the holy of holies, where stood the altar with its statue of god or goddess. Egypt's cloudless sky, the gloom of the sanctuary, which had no windows, and only a narrow door, enabled them to use these temples as telescopes without lenses. We have only to go back through the variations of the ecliptic, that is the swing of the pole round the polar star in 26,000 years, to find the exact time when this ray of light fell in the very middle of the temple sanctuary to find when the building was built, many temples have been thus dated, and the records of Egypt simplified. Some of them were built more than 5,000 years ago, others rose at different times till, in the 5th century A.D., Theodosius suppressed them as places of worship when they were abandoned, or given to the Christians to serve as churches, after which they fell into ruins.

The writer was struck with the resemblance of the Mexican ruins to these of Egypt. The Peruvians built their temple on the plan of the Nile dwellers, and worshiped the sun from whom they supposed their royal family descended. At Cusco, the royal temple was constructed so the rays of the rising sun passing through the great entrance, fell on the farther wall of the sanctuary, where was a great human-faced gold disk, image of their forefather, the sun, to whom gold was the sacred metal. Each morning the members of the royal family gathered and worshiped the sun's gold image as the light of the rising sun illumined the figure.

Greeks, most learned and scientific men of old, called the study of the stars Astronomy, "A Law of the Stars," oldest of the sciences. Ptolemy's Almagest contains records made at Babylon, giving with remark-

able exactness the positions of the stars, some of the observations having been made about 2250 B.C. which Callisthenes transmitted to Aristotle. They figured out the length of the year to within half a minute, knew the precession of the equinoxes, estimated the comets as traveling in extended orbits, and foretold their appearance. The East Indians, having come from Iran, ancient Persia, long before historic times had an astronomical system of a more northern latitude than India, or Benares, the seat of their chief observatory.

In 600 before Christ, Thales of Meletus founded the Ionian school of astronomy where movements of sun, moon and stars were observed, causes of change of climate explained, and sailors taught how to use the Greater and Lesser Bear constellations in their voyages. Pythagoras, who belonged to this school, taught the sun is the center of the planetary system, and he is looked on as one of the founders of our system. His pupil, Philolaus, taught "the earth and planets move in oblique circles about fire as the sun and moon." Cicero states, "Theophrastus narrates the sun, moon and stars are at rest, and the earth alone moves, turning on its axis, from which the same phenomena are produced as if the contrary were the case." Cnidus refused to believe these new theories, and upheld the old Babylonian teaching, that numerous celestial crystal spheres upheld the heavenly orbs.

Hipparchus of Nicaena 160 B.C. made the first catalogue of the stars, figured out movements of sun and moon, marked out motions of the planets on the theory of epicycles, "little circles," each heavenly body having one of these cycles which carried it along, and discovered plain and spherical trigonometry, Ptolemy combined all these together in his system in the Alexandrian school, found the changes in the moon's motions called the evection, the seeming changes of place of the heavenly bodies caused by the refraction of light coming through the atmosphere, and gave a catalogue of 1,081 stars. His system, which prevailed

down to the days of Copernicus, was taught especially in the Alexandrian school, till, in the 7th century, the Arabians conquered Egypt and burned the famous library. The Moslem Arabs, behind the astronomers of their day, especially in practical work, handed down to their successors the discoveries of those who went before.

In the eleventh century the science of the stars revived in Europe, but for two centuries no important discovery was made till Purbach and Regiomontanis prepared the way for Copernicus; Waltherus and others handed their discoveries down to the three great men, Copernicus, Kepler and Newton.

Latin writers tell stories of strange Hyperboreans, "the most northerners," "beyond the sources of the north winds," ruled by priests called Druids, who worshiped sun, moon and stars, believe in immortality, and imagined earth, sea and air filled with souls of the dead they called "fairies" and "good people." The north of Europe shows remains of these ancient observatories priests built in primitive forms. The British Isles have ruins of stone blocks in circles, lines and peculiar formation, oft of gigantic size, sometimes capped with cyclopean blocks, built as altars for sacrifices of Druid culture. We will say a few words on the most famous.

At Stonehenge, England, is a circle of such stones 100 feet across, at Dartmoor is a row 1,000 feet in length, in Ireland are round towers, the south coast of Sardinia shows many towers within sight of each other, and in France we find remains of these mysterious structures. For twenty years, Lockyer studied the monuments of Egypt and the west of Europe, where priest-astronomers offered prayers and sacrifices to the the "hosts of heaven." He finds them all built to face the rising and setting sun and stars, when astronomy and religion were strangely mixed with superstition.

The Druids placed the blocks at Stonehenge to look towards the horizon—to face towards the point where

the sun rose, June 20, 1680 B. C. The Druid priests followed religious rites rife in Egypt more than 1000 years before, which had spread along the coasts of Africa, Spain and France till they came to the British Isles. This old Egyptian year fixed the positions of half the ancient temples of Europe, taking the place of the old year which began May 6. This old calendar still marks May Day. The Irish and Scotch common law fixes the quarterly rent on May 1, and that is the day for moving. Some Druid places of worship and remains are fixed so the sun shone in the temple May 6th. They used the oak, their sacred tree, and the ash they loved for its sightliness to mark the movements of the stars, while temples marked the sun, the king of heaven.

Eleven lines of stone, in Cornwall, are set to use Arcturus as a clock-star. The earliest is at Tregaseal, built in 2330 B. C., five were built between this date and 2000, and others in 1990, 1860, 1720, 1560 and 1420 before Christ. The star Capella was used as early as 1320, the Pleiades served as a clock in 1270 and 1030 B. C. These stars were used to mark time, because they rose an hour or two before the sun. Near Penzance is a well-preserved circle of stone called the "Merry Maidens," sighting objects as points sometimes a quarter of a mile away where Arcturus rose Aug. 1650 B. C., and Capella Feb. 2160 B. C. Two more lines of stone show where the Pleiades set May 1960, and Antares May 1310. Thus, by astronomy, it is easy to fix the exact date when these Druid observatories were built, and how long the temple observatories remained in use.

At Hurlers, in Cornwall, are three circles of different ages, the southern being the oldest, with stones on the distant horizon marking sunrise and sunset in November and May, while another to the north is on the horizon where Arcturus rose in 2170 B. C. After a hundred years, this star did not rise in the old place, because of the precession of the equinoxes, and the Druids built

a new circle and ran a new line three degrees to the east to hit its rising in 2000 B. C. The star changed and they built a third circle in 1900 B. C., putting up a stone 1,200 feet away. In 1730 B. C. they located the place where Betelgeuse rose by a line nearly east, later south of west, the setting point of Antares, and still later another line marked the rising of Antares, and still later another line marked the rising of Sirius. It seems this Druid observatory was used for about five centuries. But the precession of the equinoxes changed the apparent places of the stars, this the priests could not understand, and it played havoc with their astronomy. For a thousand years they seem to have given up building observatories as we find none later than these dates. The conversion of Ireland by St. Patrick and of England by St. Augustine, taught them the stars were not gods to be worshiped.

In 444 B.C., seeing the stars fixed in place, and the planets wandering, Empedocles separated the latter from the former, and Pythagoras and his disciples described the planets' order from Mercury to Saturn. A century passed and Eudoxus, in the days of Plato and Aristotle, trying to explain the movements of the heavenly bodies round the earth as their center, proposed the theory of many crystal spheres circling round and carrying the stars with them. The moon had three spheres, each planet had four, and this theory explained by Ptolemy served till Copernicus' time. But new movements were later seen, each requiring a sphere, till at last sixty spheres, one within another, all revolving round the earth as their center, were imagined to explain the different motions. But the labors of Copernicus, Kepler, Galileo, Tycho Brahe, Newton and others gave us discoveries which show on what simple laws God founded His material creation.

The discoveries of these men upset the whole order of creation imagined by men wedded to old forms. These new teachings were held as impious, for they thought they degraded man by removing the earth, his

dwelling place, from the center of the universe. They thought sun, planets and stars were only for man dwelling on our earth, round which all heavenly bodies circled. Then rose wild theories holding other worlds than ours as dwelling-places of men like us.

Copernicus is the father of the new astronomy, which, since the discovery of the telescope, the spectroscope and Kepler's and Newton's laws, brought order out of the chaos of the ancients. In Thorn, a town of Prussian Poland, in 1473, lived a merchant Pole, named Niklas Kopernigk, who married Barbara daughter of Lucas Watzelrode of an ancient noble family. Elected alderman of his town he had a daughter, Barbara, who died abbess or superior of a convent of Cistercian nuns. A son was born to him Feb. 19, 1473, called after himself, known in history as Nicolaus Copernicus—Latin terms of his name.

His father having died in 1483, Copernicus was placed in the care of his mother's brother, who became bishop of Ermeland in 1489, with whom he lived till he was 19, when he was sent to the university of Krakau noted for its famous professors. There he became celebrated for mathematics, and knowledge of astronomy. He was graduated as Master of Arts in 1492, the year Columbus discovered America.

At home Copernicus studied painting and the laws of prospective. In 1496 he went to Italy and the next year we find him one of the professors of the university of Bologna, where Ptolemy's system of astronomy teaching crystal spheres, was severely criticized. As a friend and helper Maria da Novara received him and employed him in his observations of the stars while he was testing the truth of the old system. The instruments were of simple wooden construction, the work lasted for forty years, the observations were crude and filled with errors. Here Copernicus studied Greek, followed the usual course of divinity and was ordained a priest.

In 1497 he was appointed a canon of the cathedral

of Frauenburg, a life position with a salary of $2,250. He received a three years' leave of absence from the diocese to continue his studies in Italy. Later he received an additional salary from the church of Breslau. In 1499 his brother Andreas became a canon of Frauenburg—both brothers having substitutes during their absence, and with their uncle the bishop of Ermeland, supplied them with extra money. His leave of absence having expired in 1500 he went home, and received an extension of his leave of absence that he might study medicine to serve as physician to the chapter of canons of which he was a member. He took up his residence at Ferrara, Italy, went to Rome where he was received by the Pope with great honors. In 1500, in Rome, he delivered a course of lectures on the new astronomy before an audience of more than 2,000, persons. He pursued his medical studies at Padua, where famous teachers expounded Plato's and Aristotle's philosophies from the original Greek texts. Copernicus passed through all branches of human knowledge then known. He was friend and pupil of the greatest teachers of Italy for ten years, and became a man of the highest culture.

When thirty-six years old he returned to his uncle, prince bishop of Ermeland, then engaged in political broils with invading Tartars on one side, Teutonics on the other, as well as difficult church diplomacy and cases of canon law. The settling of these the bishop confided to Copernicus his nephew. To arrange matters he had to make many and long journeys. In 1512 his uncle died, and Copernicus returned to his post as canon of the cathedral, where he lived during the rest of his life devoted to study.

The chapter of canons owned some estates at Allenstein and sent him on two occasions to look after them, where he lived, each time about a year, showing what confidence they placed in him when he was in his thirty-ninth year. He was a progressive man, most learned in the sciences, perhaps the greatest genius of

his age. He examined all the writings of past ages relating to astronomy. The idea that the world was the center, that it never moved, that the sun, planets and stars revolved round the world in twenty-four hours, all held up by a multitude of crystal spheres, seemed repugnant to the simplicity of God's works in other departments of nature. After years of thought, he came to the conclusion that the world turned round on its axis each day, revolves round the sun each year, and that the planets follow the same laws. This would place the heavenly orbs on simple movements given each, explain their rotations, and take away the multitude of crystal spheres required in the ancient Ptolemaic theory.

He explained his theory to his brother canons, the idea spread to the universities, soon the two theories were taught by the same professors and disputes rose on all sides. Copernicus was a candidate for the vacant see of his uncle, the new bishop persecuted him; like all brilliant men he roused enemies, the advocates of the old astronomy were hostile, texts of Holy Writ were cited, they thought the old scholastic forms were shaken, exaggerations were rife, for man's place in nature as center and head were supposed to be taken away in the new astronomy. Peter the Lombard thus sums up the ancient sciences coming down from Greeks, Romans and teachers of antiquity. "Just as man is made for the sake of God, that is that he may serve him, so the universe is made for the sake of man, that it may serve him, therefore man is placed at the middle point of the universe, that he may both serve and be served." But the new astronomy made man an outcast, on the borders of a universe with the sun in the center. Man's place in the center tickled his pride, satisfied their interpretation of Scripture, and old traditions coming down from the origin of our race. They did not then know what the discoveries have since shown, that the earth, sun and planets are in almost the very center of the heavenly orbs

within the Milky Way. It took all these years of study and observation down to our day to show that in this respect both the old and the new astronomy are true. Man is in the center of the universe which was made for him alone.

The learned were roused by the new theory, Kepler took it up, teachers in all the schools got thinking, astronomers went over old observations, books were published advocating the new theory, and the learned divided into two hostile camps with Copernicus as the focus. Luther called him an "old fool," trying to upset the Bible, Melancthon declared the whole Bible was against him, Calvin quoted psalms against him, but the hierarchy of the Church waited to see the end, for Rome is very slow to define a religious question. In 1512–1517 the Lateran council appointed a committee to reform the calendar; in 1514, they asked Copernicus' aid, he replied that the movements of the heavenly bodies were not yet fully understood, and the chairman of the council committee replied asking him to continue his studies.

His appointment as administrator of the canons' property interrupted his studies, he had to plunge into Polish and Prussian politics, he fixed up political matters as best he could, returned in 1519, the next year was made chairman of the chapter of canons of the cathedral, after which the Prussian estates asked him to report on the debasement of the coinage and its remedies. In 1523, bishop Fabian died and Copernicus was made administrator of the vacant diocese. When Luther's doctrines were spreading on all sides, Copernicus said that the new doctrines should be combated not by force but by public discussions.

A new bishop, Mauritius Ferber, was elected in 1523, and he had his nephew Glese, who had been a member of the chapter, appointed his coadjutor. Copernicus had spent many years of his life taking observations of the stars and writing a book to prove his theory. The title was "On the Revolutions of the

Heavenly Orbs," and he confided the manuscript to his friend the new coadjutor bishop. This book which revolutionized the old astronomy and laid the foundation of the new, he dedicated to Pope Paul III. with these words:

"I dedicate my book to your Holiness, in order that learned men and the ignorant may see that I do not shrink from judgment and examination. If there be by chance, vain babblers, who know nothing of mathematics, yet assume the right of judging on account of some place of Scripture perversely twisted to their purpose, and who blame and attack my undertaking, I heed them not and look on their judgments as rash and contemptible," etc.

In 1537, Danatiscus became bishop of Ermeland, Copernicus had voted for his friend Glese in the chapter called to propose the names for the vacant see, and the latter was made bishop of Culm. The Danatiscus showed a coldness for the astronomer, ordered him to send away his housekeeper, and always remained his enemy, although Copernicus made advances of settlement. He found a warm friend in George Joachim, known to us under the name of Rheticus, who went to live with him, then in his 66th year, the young man being 23. His visit lasted more than two years, and he wrote regarding Copernicus, "My preceptor was very far from rejecting the opinions of the ancient philosophers from a love of novelties, and except from weighty reasons and irresistible facts. His years, his gravity of character, his excellent learning, his magnanimity and nobleness of spirit are very far from any such a temper."

Rheticus in this letter writes of the immense labor Copernicus went through before he announced his theory that he had examined every observation of the stars ever made, tested their truthfulness, accepted nothing which was not proved and collected an immense library. He testifies to his purity of life as a learned priest. He left his house towards the end of

1541 carrying with him the manuscript of one of Copernicus' books on Trigonometry, which he published the next year.

Copernicus sent the manuscript of his great work "On the Revolutions of the Heavenly Orbs" to his friend Glese, the bishop of Culm, who sent it to Rheticus to be put in order for the press, and it was given into the hands of Osiander, a Lutheran minister, interested in astronomy. The book in Latin, the language of the learned of that time, was printed in the beginning of 1543, and a copy placed in Copernicus' hands, May 24th, the day of his death. It had an introductory note by Osiander, which he did not sign, advocating the new theory and defending Copernicus.

The great priest-thinker ranks with the men who have thrown a luster on our race. His system of astronomy has been accepted by all men the world over. It prepared the way for Kepler, Galileo, Newton, the Herschels, the Kants, and that long line of learned men who have been the glory of their age.

Copernicus had been dead 21 years when, in 1564, the famous Galileo Galilei was born in Pisa, of a noble Florentine family. His father, a man of learning and author of many treatises on music, at home gave his son an education in common branches, the classics, music, drawing and painting, after which he attended the university of Pisa, where he studied medicine. Drawing led him into geometry and mathematics. In his native Pisa, just at the outskirts of the city, stand three famous monuments, the Baptistery, the Leaning Tower, and the Cathedral between them, all three being of white marble. Not far away is the Campo Santo, the cemetery, with many sculptured monuments of the dead, but it is not as fine as that of Genoa.

The Tower, the belfry of the Cathedral, leans out so you think it will fall every moment, but as the centre of gravity is within the base, there is no danger. From the top of this tower, Galileo made his experiments regarding the laws of falling bodies. A great

bronze lamp hangs before the altar of the Cathedral. It had just been lighted when we entered, and was swinging back and forth as such lamps do when disturbed. One day, in 1583, while praying before the altar, Galileo noticed the lamp, perhaps this very one for it looks very old, swinging back and forth. The regular time of its movements had before induced physicians to use a swinging body in counting the pulse of patients. Later, Galileo invented the clock pendulum based on his observations of the cathedral sanctuary lamp.

He read Archimedes' works, and invented his hydrostatic balance. The pump on the principle of the screw invented by this Greek the writer saw used in Egypt, showing how little these people of the Orient have changed for thousands of years. Galileo's discoveries on the center of gravity, which he gave forth in a paper he read before the university of Pisa, obtained for him the professor's chair of mathematics when he was aged but twenty-five, but the salary was only sixty crowns a year, so he had to take private pupils to eke out a support.

Up to that time, the inductive philosophy of Aristotle prevailed all over the Christian world. Centuries had crystallized his great generalizations into every school, college and university as the Master who had surveyed every landmark of human reason. But with him, all was theory; experiment; discovery, science and nature were hardly mentioned in his philosophy. Galileo had gone away from the old theory and revolutionized the ancients in his experiments.

If Galileo had confined himself to science, his own proper field, he would have had no trouble. But he unwisely entered into the domain of religion, a temptation which involved many a scientist since his day. He tried to support his scientific views by quotations from Scripture and the Fathers. His letters were laid before the Roman authorities in 1615, but they replied that if he confined himself to his system and to science,

and let Holy Writ and the Fathers alone, he would not be molested.

Galileo's case is famous; it has been a handle on which some men hang all kinds of attacks. They flaunt before us how religion is opposed to science, how these old-fashioned clergymen persecuted Galileo for claiming that the earth goes round the sun, they bring in an imaginary dramatic scene at his condemnation, and love to tell how the persecuted man exclaimed, "And still she moves."

What are the real facts? The Bible is a revelation to mankind which God gave through inspired seers of Israel relating to a Personage, foretold in almost every Old Testament page, who was to come restore mankind to innocence lost in Eden, and build an empire of religion over all the earth. He is called in the Hebrew the Messiah, "the Anointed," a name translated into Greek, "Christos."

The Bible relates to faith and morals, belief and practice, right thinking and right living, telling how men save their souls. It is mixed with history and prophecy, written in an age hard to understand, and no translation can give the wonderful beauties of the original. It is written in the language of the people of that day so they might understand it, and is filled with terms and expressions current in these times. It is not a book of science but of religion. Galileo tried to prove his theories from the Bible. He entered the field of religion and made himself liable to be brought before the court of religion. They passed on his theories inasmuch as they related to religion, told him to let religion alone, to keep to science and he would not be disturbed.

Suppose a man attacks the Constitution of the United States. induces people to rebel, commits any crime or preaches anarchy. He is brought before the court. The court hears the case, does not pass on these peculiar doctrines, but enjoins the man not to preach such things again. He goes out and soon begins again to spread his

doctrines. He is brought up before the court, not for his doctrines but for contempt of court, which had forbidden him to preach anarchy. The truth or falsity of his doctrines have not been passed on, but his disobedience or contempt of court is before the judges and he is condemned for this alone. He goes out and the papers are filled with exaggerated accounts of the case, writers mix things up and the tyranny of the United States is heralded all over the world. The Government is against progress, hostile to science, books are filled with all kinds of attacks on the members of the court and the American people. Europe takes up the question, parties here are roused, and all over the world are published statements that there is no liberty of conscience in this country. This would be a case like that of Galileo.

In human minds two worlds exist, the spiritual and the material, thought and the visible, mind and matter; one the object of the intellect, the other the object of the five senses. The first is the domain of religion, the other the field of science. These two are separate fountains of study, both have God as their origin, both tell His wonders. These branches of learning are ruled by separate laws, they do not conflict; one cannot deny the other, in both the object is truth revealed by God forming these two great departments of human knowledge. There is no conflict between science and religion except in minds of men who do not fully understand both.

It was revealed man is the end of all the material creation. Every man feels by deepest instinct he is superior to beast, he is the head of creation here below. The world, made for him in the center of the universe, had come down from remotest times. Ptolemy and the ancients fixed the world in the centre, round which revolved the stars on numberless crystal spheres. But as newer observations multiplied, spheres forming the machinery of the heavens became unwieldy in this system, and the movements of the

orbs could not be explained according to the laws of mechanics and figures.

Toward the end of that year, he went to Rome, where he again tried to prove his system from the Bible, and for that reason his works were placed on the Index, till Benedict XIV removed the prohibition. He was encouraged to continue his experiments in science, and again told to let religion alone. No Pope himself ever condemned him, but only the court appointed for the examination of bad books, passed sentence. The decree of this court, till it was approved by the Pope, was only a human sentence, and did not involve the Papacy. Not understanding this, or not going down deep into the facts, writers blame the Church when she was not involved. The case itself set limits to Church authority, the proper domain of its authority being faith and morals, belief and practice, right thinking and correct living, and not science, when the latter does not attack religion.

He had an audience with the Pope in 1617, who assured him he would give him every protection in his studies of nature, if he kept out of religious questions, after which he returned to Florence. But small men still attacked him. When his friend who became Urban VIII was elected to Peter's Chair, he went to Rome to congratulate him, where he was received with the highest honor, esteem and liberality, and the Pope granted him a pension of 100 crowns a year and 60 to his son.

About 1597 Galileo became a convert to Copernicus' system, that earth and planets revolve round the sun, and wrote a letter to Kepler on the subject. He lectured with such wisdom at the university, that crowds came to hear him so that sometimes he delivered his discourses in the open air. In 1609, a report reached him that a Dutchman had made a glass which would magnify objects, and at Padua he made a glass which would magnify three times, which he presented to the senate of Venice. He then made an-

other which magnified eight times and still a third with a power of 30 diameters. This he now turned on the heavens, and for the first time he saw the wonders of the celestial orbs. He examined the moon, mapped out its face and discovered Jupiter's satellities. His discoveries were received in some quarters with ridicule. He then made a compound microscope which he presented to the king of Poland. The world would not believe the wonders he revealed, and from that time he published his discoveries in riddles. He went to Rome in 1611, and raised his telescope in the Quirinal Gardens, then belonging to Cardinal Bandini.

He wrote a book setting forth his system, which he filled with quotations from the Bible upholding his theories, even after he had been forbidden to cite Scripture. In this book he protests that the former decree of the court had not been rendered through ignorance or passion, stating that the members of the court listened to his words and explanations with great attention, that the sentence had been rendered on purely religious grounds and that it did not touch science pure and simple. He had been forbidden to mingle religion with science and had promised to obey, but the publication of this work broke his promise. Brought before the court again he was condemned not for his science but for disobedience—contempt of court. Going to Sciena he passed a considerable time with the archbishop as his guest, after which he returned to Florence and retired to his own house at Arcetri near that city, where he passed the rest of his life. He published many books relating to scientific subjects, and was not again disturbed because he did not enter into religious questions. He died in 1642.

Kepler, a famous astronomer, was born of a noble family but reduced in fortune, at Magstatt, Germany, December 27, 1571. He served for a time as a servant of the duke of Alva, went to a monastic school where he prepared for the university of Tübingen, where he took his degree of M. A. and began the

study of astronomy under Mostlim, one of Copernicus' disciples. Later, at Tycho Brahe's invitation, he went to Prague, where he helped the latter, then the most famous astronomer of the world.

He devoted himself to opties, described the eye, found the laws of light passing through transparent substances, turned the telescope Galilee had invented to the stars, found that Mars moves not in an exact circle but in an ellipse, with the sun in one of the focuses, and published his three famous laws in 1609 as follows: 1. Every planet describes an ellipse about the sun, this orb being in one focus of such an ellipse. 2. If a line be supposed continually drawn from the sun to any given planet, this line will sweep over equal areas in equal times. 3. The squares of the periodic times of the planets are proportional to the cubes of their mean distances. Since his day every astronomer found these laws rule the motions of the heavenly orbs. They are the foundations of order and of movement the Architect of worlds gave to rule their revolutions.

In Professor Playfair's words, "The discoveries of Kepler were secrets extorted from nature by the most profound and laborious research." Logarithms had not been discovered till the Scotsman Napier figured out the tables which enable men to shorten their figuring, calculus was not known, and Kepler's figures on the seven oppositions of Mars fill 700 pages. We will not give his complete history. He lived in extreme poverty, his wife and his eldest child died with smallpox. Looking for a wife he subjected eleven candidates to the same analysis as he would the movements of Mars. He died in 1630 of a fever brought on by fatigue and anxiety and was buried in St. Peter's Church, Ratisbon.

Tycho Brahe, born in 1546, in Scania, of an ancient princely family, the second of ten children, studied first under tutors, went to Copenhagen to learn philosophy, and later to Leipsic where he took a course of law. His people wanted him to be a lawyer and

statesman, but the foretelling of an eclipse of the sun in 1560 attracted his attention to astronomy, to which he devoted his life. A large fortune left him enabled him to devote his whole time to the science at his uncle's seat near Knudstorp, Denmark.

Later the king gave him the island of Hven in the Sound, there built for him a laboratory and observatory, where most distinguished persons from all parts of the world visited him. He was made a canon of the church at Roeskilde and allowed a pension of 2,000 crowns a year, besides 1,000 crowns from the church. Political troubles forced him to flee to Denmark, the emperor Rudolph of Germany received him with great honors in 1599, settled on him a pension of 3,000 gold florins, and gave him a residence in his own castle, Benach, near Prague. He died in 1601 and was buried in one of the chief churches in Prague. He did not fully adopt Copernicus' system, but his discoveries paved the way for the astronomers who came after him.

Sir Isaac Newton, the famous English philosopher, was born Dec. 25th, 1642, and died March 20, 1727. From his youth he worked at little mechanical inventions, at nineteen he entered Trinity College, Cambridge University, where, as a student, he worked out his binomial theorem and wrote a treatise on optics. Galileo had invented, and later Huygens improved the telescope, but it was imperfect, as the glasses were not made as well as in our day and he constructed the first reflecting telescope, using a mirror called the speculum.

Being at Woolsthorpe he saw an apple fall, and this set him thinking, "Why do bodies fall?" He connected the weight of all bodies with gravity which holds the orbs and all the planets in their course. All bodies are heavy; that is, they are drawn towards the center of the earth. This weight grows less according to the distance of the body from the center of the earth. He showed that the moon is drawn to the earth in the same degree that the square of the distance exceeds

the distance of points on the earth's surface from the earth's center. He proved that when the force of the attraction diminished according to the law of the inverse square the attracted body will obey all Kepler's laws in its motion round the attracting orb.

Then he inquired into the mutual perturbations of the heavenly bodies so moving, and showed that the several motions of the moon which could not be explained before were caused by the sun's disturbing action in different parts of her orbit as she turned round the earth sometimes nearer sometimes farther from the sun. Then he showed that the procession of the equinoxes could be caused by gravitation, and many phenomena of the heavenly bodies, which up to that time could not be explained. His chief work, the Principia, "Principles" contain his great discoveries.

For the next half century, learned men set themselves to explain the motions of the heavenly bodies according to Newton's discoveries of the weights of the orbs. Lagrange and Laplace figured out the mechanism on which the orbs were founded and showed that they will go on forever.

Newton's discoveries took the world by storm, and men set to work to criticise or find the truth of these great "Principles" on which the Mathematician of nature founded the universe. Everywhere the mighty Mind of God was seen in the mathematics and figures laid down for the orbs to follow in their courses. A clock regulated for Paris lost 2 minutes and 28 seconds at Cayenne within five degrees of the equator, other experiments showed variations of clocks and Newton found the earth to be 26 miles shorter in diameter through the poles than through the equator.

Kepler had spoken of the attraction of the sun and moon for the waters of the oceans, Newton took up the matter and explained the tides and the disturbances in the flight of planets round the sun. Then he went down deep into the laws of centrifugal and centripetal forces—that is, the tendency of orbs sweeping round

their premary to fly away and then to fall into the sun or moons of the bodies circulating round their primaries.

His most famous work, written in Latin, of which the following is the translated title, "The Mathematical Principles of Natural Philosophy," contained the germs of nearly all his discoveries. It is divided into three books—the first treats of motion in free space, the second of resisted movement, and the third the system of the universe concluded from his other two books. His deep reasonings along the higher mathematics in the Latin language in which he wrote prevented his wonderful discoveries being known except among the learned. Even scientific men, steeped in the old Ptolemaic astronomy, did not believe his theories. Frenchmen still followed the Cartesian system, and Voltaire said that at his death Newton did not have twenty followers outside of England. But soon after the publication of his "Principles" the universities of the British Isles introduced his philosophy and a long time afterward the learned bodies of the Continent adopted them. He devoted the rest of his life to developing different points of his philosophy, entered parliament and corresponded with the most learned men of the world.

He was without doubt the greatest mathematician of his age, and this enabled him to find out the secrets of the mighty Mind who built nature on the plans and figures of His Wisdom. Both he and Leibnitz claimed the discovery of infinitesimal analysis, and a controversy sprang up between them. Many disputed his claims and controversy imbittered his later years. He was so religious he took his hat off when he heard the name of God, and was called "the excellent divine" because of the worship and respect with which he honored the Creator whose works he had penetrated in nature. He left many works of a religious nature written in Latin, but they were never published. He wrote four celebrated letters addressed to Bentley against atheism, to show that matter could never have

arrayed itself in its present forms of orbs, movements and forces without a divine Power. He was never married, and his niece had charge of his home. This most famous and good man died in 1727 at Kensington, a suburb of London, and was buried in Westminster Abbey, where a monument was erected over his tomb in 1831, almost in the middle of the carved screen shutting off the nave from the ancient chancel or choir.

CHAPTER XII.—WHAT IS MATTER MADE OF? TWO OLD THEORIES.

Less than 100 metals and their unions compose the visible universe. Some are solids which become fluids or gases by heat, such as iron, gold, copper, tin, etc.; others are gases at ordinary temperature but can become fluids or solids by cold and pressure, such as the gases like oxygen, hydrogen, nitrogen, etc. These are all called primary elements because we cannot divide them into other more simple substances. Whether solids or gases we call them metals.

We would like to know what these elements or metals are composed of. There are two theories. The oldest comes down from prehistoric days stating all metals or primary elements are composed of matter and form, or extension and force—that matter is a focus having length, breadth and thickness and activity attracting and repelling, etc., the forces we find in material substances.

This primeval matter with extension alone and which we now name Ether, was created by God from nothing and filled all the universe we call space, as the foundation of matter. In certain places God added to this ether, or primeval matter, different forces, activities or energies, making the different metals act in their own peculiar ways so they became gold, hydrogen, carbon, silver, copper, etc.

Beyond historic days Greeks sang of this primeval matter they called ether, from *aither* "upper air," or "to burn." They held all material things—earth, sea, sky, and heavenly bodies were made of this cosmic element they deified as luminous ether. Orphic hymns

sing of Ether, "Soul of the World," from which comes life. Anaxagoras said it was the principle of life. Plato describes it impure matter diffused through space, lighter than air, and held its forms or forces could exist separated from it. Aristotle wrote, ether is the primeval element of the universe, and that different forces or energies were added to it at creation.

Early Church Fathers, adopted the theory of ether from the Greeks. St. Augustine many times mentions it. The Schoolmen of the middle ages, following Aristotle's teachings write of it. St. Thomas Aquinas codified all human learning along the lines of matter and form. The most learned men of our day find they cannot explain light, electricity, heat and the movements of matter in orbs, chemistry or physics except along this theory.

The gist of these teachings is that luminous ether pervades all space, enters into and is the foundation of all material substances. Whatever we see by the senses has ether clothed with different activities which act in their own peculiar ways on our five senses. Here we are on the borders of human knowledge. But it seems reasonable to suppose that this ether was first made through space. Then in places God added to its activities forces we call appearances, each differing for each metal, and thus the metals composing the universe were made. These materials acting according to weight fell together in places Providence marked out and composed the millions of orbs. They still act along mathematical lines in chemistry, etc.

These are the physical forces of nature. But there are other forces God made—the lowest living force is in plant, higher is the living force in animal, a still higher is the reasoning soul of man partly buried in matter, then come angels free from matter, and at the head is God Eternal. This great summary comes down almost from the origin of our race and has been beautifully explained and developed by most learned men of mankind.

Democritus, born at Abdera, Greece, 460 B.C., denied this theory, taught matter is composed of little round indestructible bodies he calls atoms, "cannot be cut." But before his death his theory was abandoned as being absurd and unprovable, and the theory of ether occupied the field till modern times, when infidels of France, denying God, roused the people so that in blood, murder and carnage, the revolution swept away the old landmarks of human learning.

Lavoisier, a celebrated chemist, born in Paris in 1743, revived the theory of atoms and molecules. He perished on the scaffold in 1794, but the theory survived him. Newton took it up and his influence spread it among his followers, but when they began to study light they were forced to abandon atoms and molecules. Huygens, Descartes and scientists of their day rejected the theory for that of ether, which the latter calls "a subtil medium." To-day our most learned men are advocating the theory of ether in place of that of atoms and molecules.

As the atomic theory is still taught in nearly every school, college, university, is found in text-books, and runs through scientific works written by men who never heard of the theory of ether—matter and form, we will stop to look into this most reasonable explanation of the constitution of material things.

An atom is the smallest particle which can exist. A number of atoms unite to make a molecule, and a lot of these gathered according to natural laws form all we see through the five senses. Atoms and molecules are supposed to attract and repel other materials, each force acting according to mathematical laws. But no one ever saw an atom or molecule, for the former are supposed to be so small that if you could magnify a drop of water as big as the earth, the atoms would appear only as large as oranges.

Matter motionless was created from ether in forms of cosmic dust, metallic vapors, gases in different parts of the spaces of the universe. Then the Spirit of God

moved over the waters, gave attraction or weight to these materials by which they attracted each other. They fell down together, formed larger and larger masses which gathered in the smaller particles within the influences of the larger attracting masses. As these particles fell down through spaces of vast extent, where are now the stars, they came together with tremendous swiftness, struck with awful force and, suddenly stopped in their flights, developed the heat and light the suns have been giving out since. Thus we trace heat, light, electricity—all natural forces, back to the Primeval Force, God, who at creation made all things as object lessons of His own Almighty power. So neither matter nor force can ever be destroyed by man; only God who brought them forth can destroy them.

But these natural forces act not in any irregular way. They are all ruled by the strictest mathematical laws. Figures rule the whole physical universe to the utmost limits of the universe. Mathematics require a mind. Law calls for a lawgiver. Who is the Mind from whom these mathematics came? Who is the Lawgiver who gave nature these laws? There must have been a Wisdom infinite who presided over creation, and who still rules nature.

What holds all things to earth? What keeps sun, moon and stars from flying away from their orbits? Their weight, which Newton called universal gravitation. He announced that law in the following words: "Every particle of matter in the universe attracts every other particle, with a force whose direction is that of the straight line joining the two, and whose pull is in proportion directly as the product of their masses, and inversely as the square of their distance."

That law rules every particle of matter in the universe—even the materials of our bodies are subject to it, for we are heavy. What are the unseen cords ever pulling us towards the center of the earth, and holding heavenly orbs in their unseen grasp? Atoms and mole-

cules cannot explain that mystery. We can only say it is one of the forces God gave matter at creation.

Each metal has its own proper weight. Some are very light, especially the gases, as air, hydrogen, oxygen helium, etc. Other metals are heavy, as gold, platinum, iron, etc., while some are light, as aluminum, the base of clay. The energy or force given ether at creation makes them act this way. Each metal and gas has its own way of acting according to the mathematical activities given at creation.

But they do not act in wild and irregular ways, for nature was not built on chaos, but on law. These laws which rule nature were founded on mathematics. Figures rule the whole universe from the smallest particle to the greatest sun.

The ancient theory that material things are composed of matter and form, or ether and energy, or extension and force, has recently been confirmed in a remarkable way by the discovery of many radio-active metals and the system of atoms and molecules which so long misled men has been proved false. We will enter into this matter in detail, because it has such a bearing on our subject, and because men of science are so wedded to atoms.

In 1876, Rutherford accidentally left a piece of pitchblende in a dark room, on a sensitive plate used by photographers, and found it printed an image on the plate. This material produces light rays we cannot see. The Curies, man and wife, by chemical analysis, in 1898, boiled down tons of pitchblende, gathered the metal which produced these rays, and called it Radium, "light-giving." Long before, the spectroscope had found a mysterious gas in the sun, called helium, and it was found that radium produces this gas.

The writer saw with his own eyes radium, the most powerful of the light and heat-giving metals. In a glass-case lay a number of little round glass tubes about five inches long and thick as a lead-pencil. "These are bromides of radium of different purity,"

said the attendant. "They keep hot all the time, and give light in the dark. Here, take one in your hand."

The bromide of radium occupied only about one-fifth of the tube, but the end holding the whitish-gray metal was warm, while the empty end of the tube was cold. It was a gentle heat—not enough to burn the fingers. Other tubes were placed in the writer's hands, the purer or larger the quantity of radium they held, the warmer the tubes were. It looked beyond belief. Here was heat created before your eyes. All experiences told you heat must have an origin as fire, or motion; but here was heat, coming from a metal which would continue to give out energy without loss of substance for years.

"Come and I will show you something," said the man in his beautiful French. He led the writer into a dark room and closed the door. "Here is some pure radium under this magnifying glass." The writer looked down through the little lens of the metal case, and saw a small roundish mass of radium about as large as the head of a small pin. Once, twice or four times a second out from the radium shot streams of light like little lightning flashes. Sometimes one, then two, or many brilliantly flashing white outbursts shot out like electric discharges to about five to six times the diameter of the radium. They looked like little explosive bursts or most brilliant streams of white fire, darting hither and thither, to be lost before reaching the sides of the case, the latter being warm in the hands of the writer. Mine eyes have seen a miracle of nature, a metal which without loss of matter of any kind produces energy, light and heat. Here the force, form, or energy of the metal was active. Here was a practical denial of the theory of atoms and molecules.

Some radium radiations cannot be seen with naked eye, no more than you can see the X-rays. But they become visible when passed through a screen of willemite—zinc cilicate. Some years ago Edison told the writer to put his hand on a screen of barium platino—

cyanide, while the great inventor behind turned on the X-rays. Every bone in the writer's hand stood out; the flesh was seen as shadows; you could see the outlines of the hand, but the bones looked exactly like a skeleton hand. This is the way bones and interior parts of the body are now photographed in surgical cases.

Radium sends out three kinds of rays, called after the Greek letters *a*, *b*, and *g*. The *b* rays are deflected by a magnet, which bends them out of their course; if the other pole of the magnet is brought near, they are deflected in the opposite way. They seem to be identical with the rays sent off from the cathode of a strong electric discharge in a vacuum. Thomson found they have a velocity of 50,000 miles a second. Kaufmann says that some of the *g* rays of radium have a velocity of 170,000 miles a second, almost that of light. They pass through several inches of solid lead, through a foot of iron, penetrate many metals, are not deflected by a magnet, or electric current, and appear when the ether waves strike certain objects.

The *a* rays of radium have very little penetrating power. After passing through a quarter of an inch of air, they are stopped by a piece of paper. The rays of radium light are 40,000 times swifter than a rifle bullet, act like rays of electric light through a vacuum tube, and divide into three rays—the *a* ray acts like "canal" rays Goldstein discovered, the *b* like the cathode rays of the electric light, and the *g* ray are similar to the Roentgen ray.

Radium gives out a gas which condenses at —150°C. Thorium produces a gas which condenses at —120°C, these falling on inclosing mental tubes make them shine in the dark. That of radium reflected from willemite is green, from kunzite, dark red; zinc sulphite is white, barium platino—cyanide, at first is green but changes.

Radium light kills microscopic plants and animals which cause disease. The gas is found in numerous mineral springs—waters famous for their healing

powers. The discovery of this mysterious metal spurred on scientists and soon numerous metals were found which give out energy. Becquerel found uranium produced light, heat, and a gas. Debhirerne found arctinum did the same. In 1898 the two Curies discovered another metal with radio-activity and called it Polonium, after the lady's native land. These discoveries showing metals have activities utterly upset the theory of atoms, and uphold that of ether and energy.

CHAPTER XIII.—THE PHYSICAL FORCES—WEIGHT, HEAT, LIGHT, ELECTRICITY, ETC.

Will you say no men wrote the books in a library, that no one made the figures covering the papers on his desk if you enter his office while absent? We find all movements of material things are ruled by mathematics. In the sky, on earth, in chemical changes, in physics, we find figures. Regular proportions according to arithmetic, algebra, geometry, trigonometry, conic sections, infinitesimal calculus, logarithms—all the mathematics and some sciences we have not yet discovered are in nature. Did stones and rocks and metals think out these figures? Did they go to school as we did to learn these figures regulating them?

Mathematics are the expressions of mind—only a reasoning person can learn or know them. The mathematics of nature were there before we found them. They are the purest and most absolutely true truths we know. They are eternal in the past, and will be true in eternity; for they are universal truths. Where were they before nature was made and set going according to them? They were in the eternal Mind. They are the expressions of His Wisdom, the Thought coming forth in the eternal Now of God, for with Him there is no past or future.

Newton discovered that weight attracts all matter in the universe according to the inverse ratio of their distances, and keeps the universe together. But all materials have not the same weight. Helium, hydrogen and all gases are light. Aluminum, a solid, is light; gold, lead, iron, platinum, etc., are heavy. Each thing has its own weight, acting according to its nature.

Who gave these materials these attractions acting according to mathematics?

By its powers of growth and nutrition the soul took in earthly materials, and built them into our bodies, making these earthly habitations one with us. But the matter of our bodies did not lose their physical powers of weight; therefore we weigh each according to his size. By weight we are in union with every particle of matter in the universe. This weight keeps us on this earth, without it we would rise in the air and go wandering through space, where we would die with the awful cold. What is this weight? Why do things fall to the ground? What material bonds pull the orbs together, keeping them in their paths? We do not know—it is the greatest mystery; no one has ever given an explanation.

Mathematics rule matter but cease in living organisms. For living beings are ruled by instinct. These are so wonderful, show such astonishing wisdom in beings which do not reason, as plants, animals, and the plant and animal functions of man beyond our control, that we must conclude instinct is the Mind of God directing creatures. There is no other conclusion a sane man will draw unless he be an ignoramus.

Let us learn a lesson of the wisdom of the mighty Mathematician from the minute divisions and unions of matter. For He who planned the mathematics of the millions of suns and planets, never forgets or neglects the finest tiny particle of matter on earth or star.

Let us see what chemistry says. The word comes from Chemia, Egypt's ancient name, or from the Arabic kamia, "hidden," "secret,"—whence alchemy, a fabled science which flourished once and which took its rise in the fourth century, teaching how baser metals might be changed into gold.

Alchemists found materials in their unions and divisions follow laws of weight. For example, a given weight of alkali unites with a certain weight of acid to

form a salt. For all unions and dissolutions take place according to laws of mathematical proportions. But where two materials unite in equal proportions, they may also come together in other proportions. Suppose two materials come together as A and B in equal weight or volume and make a new substance, they may also unite in other proportions and form entirely different substances, as $A+B_2$, $A+B_3$, $A+B_4$, $A+B_5$, $A+B_6$, etc. Again, if they unite with each other in these proportions, they may unite with a third, the proportions of the first two are preserved, while the third in uniting with them follows its own mathematical laws. All the power of mankind cannot change one of these proportions or figures. Materials will unite according to their own figures and in no other way. These figures show the exact proportions or weight of the materials uniting or dissolving. Books on chemistry are filled with these figures and formulas. The first letter of the substance stands for it, and the figure following shows the proportion it will unite with another substance. When a compound substance is dissolved, the materials forming it will also follow their figures, regulating either the amount or weight of the substances. Where the letters are alone without any figure it means in the proportion of 1.

Every breath you draw into your lungs is composed by weight of 23.2% of oxygen, 76.7% of nitrogen, with about 0.1 carbon. The oxygen is in two forms—one being the ordinary gas, the other being in an active condition called ozone; the latter being more condensed and one half heavier; 100 cubic inches of ordinary oxygen weighs 32 grains, while ozone of the same bulk weighs 48 grains. While ordinary oxygen is made of double quantities of the gas, ozone, from the Greek "to smell", is composed of three quantities. This ozone given out by plants is found in larger quantities where vegetation flourishes and for animals is the life-giving property of the air. You breathe it in all the time, and the red corpuscles of the blood bring it to all

parts of the body, where uniting with carbonic gas in your system the union causes a gentle heat which keeps your body warm.

When you drink water you take H_2O, that is two volumes of hydrogen and one of oxygen. The latter gas enters into both air and water—how different these two materials. Oxygen, nitrogen and hydrogen compose all water and air.

Sodium, discovered by Davy, unites with oxygen according to Na_2O and the combination is soda, but uniting as Na_2O_2 it is a dioxide. With water it unites into NaHO, a hydrate—caustic soda NaI is an iodide; NaBr is a bromide; NaF is a fluoride while $6(NaF)Al_2F_6$ is the mineral cryolite. Pass sulphurous anhydride over moistened sodic carbonate, and you get the salt $Na_2SO_3\ IOH_2O$ used to bleach the wood pulp of which the paper of this book is made.

Thousands of unions founded on mathematics might be given but they would fill many books. You will find them in any work on chemistry. All chemical changes take place according to these mathematics which never change. We know just what we are going to get when we start to make a mixture. A man of reason and understanding will ask: Where did these figures come from? Do these little particles of matter reason and say to their neighbors: "I will unite with you according to these figures and no others"? Can crude matter reason? Did man put these figures there? There is only one explanation of these mysterious figures of matter regulating unions and dissolutions, filling books on chemistry. A Mathematician infinite in wisdom, He who created matter, knew how to figure, He laid down these mathematical laws ruling nature. There is no other solution of the wonder.

But that is not all. Every particle of matter is heavy, for it has weight. The elements of matter unite and separate according to their weight. Let us take the gases. The weight of hydrogen is 1, that of oxygen is 16, sulphur vapor is 32, chlorine 35.5, iodine vapor

127. When these unite they come together in these weights. That is Watts' law. Who gave these gases this law? A law supposes a Lawgiver with power to make and enforce the law.

The volume of all gases is the same in combining or uniting, except phosphorus and arsenic, which are only half those of the other elements, and mercury and cadmium, which are double those of the other elements. Gay-Lussac showed that the unions of elements take place in definite and multiple proportions, and you know what multiples are in arithmetic. The volume of a compound gas always bears a simple ratio to the volumes of its elements thus:

1 vol. hydrogen and 1 chlorine form 2 vols. = hydrochloric acid.
2 vols. hydrogen and 1 oxygen form 2 vols. = water, vapor, steam.
3 vols. hydrogen and 1 nitrogen form 2 vols. = ammonia, etc.

Thus it runs all through nature. Figures rule matter throughout the universe. Again we ask, Who did this?

The elements unite in different proportions according to their heat. A certain heat will produce a certain kind of union, and this is inversely proportional to their specific heat. The same amount of heat is required to produce a given change of temperature in 7 grains of lithium, 56 of iron, 207 of lead, 108 of silver, 196.7 of gold, etc. Did no Mathematician preside over these things from the beginning?

Faraday showed an equivalent of an element consumed in an electric battery produces an exact chemical decomposition. For example, 32 grains of zinc will produce a current of electricity which will decompose 1 grain of hydrogen, 108 of silver, or 39 of potassium. These results of most careful experiment show that matter rests on figures in its most minute forms and most subtile actions. It proves that some One who

knows figures rules matter in all its acts. We cannot go over all the elements, the thousands of unions, divisions and chemical changes materials pass through. But we have given these few examples that the reader may judge how figures and mathematics rule nature. Will you, gentle reader, say stones, clays, minerals, fluids and gases can reason, and by themselves alone follow arithmetic and the higher mathematics, which only men know who pass through a university?

Dalton investigating minute forms of matter, discovered many of its laws. All matters in most minute quantities act according to law. All particles of the same size and same materials have the same weight, and different elements have diverse weights. These relative weights unite with other materials according to mathematical numbers. These minute quantities have mutual attractions and repulsions. When they unite to form new materials, these little materials do not interpenetrate each other, but place themselves in positions, one beside the other, according to strict laws, founded on mathematics—a constant ratio being maintained represented by the figures given in chemistry. These discoveries prove that a mathematical Intelligence laid down the laws and movements of these tiny particles according to figures, and presides over the chemical unions, structures and compositions of matter.

We seldom find the primary metals of which the universe is composed in a pure state, for they are nearly always united with one or more of the other elements. A union of two primary elements is called a binary. Thus a certain part of carbon unites with a certain amount of oxygen in a wood or coal fire, and the product is carbon monoxide, or with two parts of oxygen which becomes carbon dioxide—these two unions producing smoke, or the vapor rising from a fire or the chimney of a lighted lamp. As the oxygen we take into our lungs and which is required to sustain animal life has combined with the carbon, the product of a

fire is disagreeable to us, for we could live but a few moments without oxygen.

Oxygen unites with many metals causing rusts, called the oxides of these metals. These oxides united with acids produce various kinds of salt. In all these unions figures are followed, proportions are guarded, ratios are observed, mathematics rule. It is utterly impossible to unite these materials except according to these figures. When metallic gases, as hydrogen, carbon, oxygen, nitrogen, etc., unite with metals they become solids. We can make these gases solid by excessive heat and pressure, but how they become solids uniting to metals we do not know. When materials unite they lose their old activities, and new activities rise different from the composing elements. The new substance becomes a whole, a unit, an independent material.

The primary metals or elements range themselves in six groups—the following Greek words express the way they combine, as monads, "sole," "one"; dyads, "doubles"; triads, "threes"; tetrads, "fours"; pentads, "fives"; and hexads, "sixes." Some add a seventh. These unions make all the materials of the universe. The monads, of which hydrogen, chlorine and potassium are examples, combine only with single particles of other materials. All other primary materials unite with 2, 3, 4, 5, 6, single elements or their equivalents, for their powers act along the lines of their attractions according to these mathematical numbers. Hydrogen, represented in chemistry by the letter H, is a monad; oxygen, O, is a dyad; Boron, B, is a triad; carbon, C, is a tetrad; nitrogen, N, is a pentad, while sulphur, S, is a hexad. You see how nature is regulated in its most minute changes by a Mathematician of infinite wisdom and power.

Water is composed of oxygen and hydrogen—one part of the former with two parts of the latter, and chemists represent it by H_2O Carbon dioxide in smoke

is CO_2 but marsh gas is CH_4. It would tire the reader to go over the whole domain of chemistry—the science treating of the unions of materials; but we have given these specimens to show the mathematics of the minerals in their unions and disunions. Figures rule them in the most minute particles. Where did these minerals get these figures?

These tiny particles of matter not only act according to these figures, but they also seem to have passed through the higher mathematics to be graduates of universities. They form crystals, a word coming from the Greek krystallos, "ice." The whole crust of earth in its solid parts is crystalline in formation. Granite, lava slowly cooled, marble, iron-ore, all materials perfect themselves by crystallizing. Look at a piece of polished granite or other stone, and you will see the crystal forms. Carbon crystallized is the diamond, the sapphire and ruby is crystallized alumina, quartz is crystallized silica. These last united with one or more of the alkalies become the tourmaline, garnet, feldspar, etc. All precious stones are simply polished crystals of different materials.

One with a wonderful knowledge of trigonometry presides over nature in the unions of materials. We see His works in the crystals.

A crystal is bounded by plain surfaces arranged in a regular way about lines called axes, having the very same structure in every part no matter how minute, and it splits or breaks according to these lines. There are six kinds of crystals—isometric, having the same elements but in different proportions; tretagonal, having four sides with two kinds of axes; orthombic, having three systems; trimetric, with three sides, angles or points; monoclinic, in which one of the axes is obliquely inclined; triclinic, in which three of the axes are inclined, and hexagonal, having six sides and six angles. Let the reader remember his geometry treating of surfaces and angles, take up his trigonometry, recall his studies in the higher mathematics, let

him apply these studies to crystals, and he will find that the crystals have followed these branches of higher learning, being learned far beyond the ken of man. Pick up a little sand, put one grain after another under the microscope, and you will see that each is a crystal, or a union of them, the materials of which when becoming solid followed these higher mathematics. Who made matter take these mathematical laws, from the tiny grains spread over earth, forming soil, to the granite and rocks of the mighty mountains rearing their heads high in the air?

Most crystals are square or six-sided. The four-sided are either right prisms or inclined, the former has three axes crossing in the center, and the latter has four axes—one vertical and three lateral. Salt, sugar, borax, etc., are examples of the four-sided crystals. Water in cloud-drops, being free to act, in freezing forms the most wonderful crystals. It would take many pages to describe the wonders of a snow-flake, each little crystal shoots out at an angle of 60°.

The details of all the crystals would fill a book. Sides, angles, axes differ for each material which crystallized. Light passing through them is changed according to the angle it strikes causing the gleam and luster of the precious gem which changes color as the wearer moves. The diamond dissolves light into its primary colors and flashes it back with a radiance no other material possesses. Yet this diamond, so precious, so hard, so beautiful, is only crystallized carbon, differing not from the coal in your stove uniting with oxygen to cause heat.

Materials take time to crystallize. Dissolve sugar into a thick syrup and cool it quickly and you have a soft stringy mass of candy. But let it cool slowly and you have rock candy, for the sugar has crystallized. So the great melted mass of glowing rock forming the crust of our earth cooled slowly, and crystallized into the granite foundations upholding soil surface and mountain. In California, Mexico, on the sides of

Vesuvius, and other volcanoes, the writer examined the lava thrown out by volcanoes. Where it slowly cooled it crystallized into granite. Where the flow was so thin it quickly lost its heat, it shows no sign of a crystal, for the materials did not have time to range themselves according to mathematical forms before they cooled.

Who gave these mathematical laws but the Almighty Mathematician? You call them nature's laws, leaving out nature's God, taking away the glory belonging to the Eternal. For nature cannot think or reason. We are naturally inclined to paganism of old which deified and worshipped Nature in place of God they did not know. Let us now see these natural forces more in detail.

What is light? Newton and his disciples, following the theory of atoms, molecules, etc., held it was caused by millions of minute particles shot out from light-giving bodies. But this theory found so many difficulties it was abandoned.

Fresnel proposed the wave theory in 1821. Cauchy in 1829 held that the ether filling star spaces is extremely elastic. In 1835 Neumann, whose work was reconstructed in 1835 by Kirchoff, and by MacCullagh in 1837, added ether of a fixed density with changing elasticity, put in vibration by luminous bodies. Rayleigh, Maxwell, Green, and a host of able men worked on light theories. From 1888 to 1890 Lord Kelvin published his mathematical examinations of light. He went over all the different theories and subjected them to strict analysis. A number of famous men investigated the question: How can light come from the stars to us unless there be some kind of material between the stars.

The conclusion of all men of science is that light is a trembling of this ether put in vibration by hot bodies —as waves or pulsation of air cause sounds, so pulsations of ether cause light. The length of these waves or pulsations have been measured—they are from

1/37,000 for red light, to 1/59,000 of an inch for violet light. After long and careful experiments at the Bureau Internationale, Paris, they found the standard platinum-iridium meter kept at Sevres, near Paris, on which all measurements are founded, to be 1/553,163.5 of the red waves of the metal cadmium, 1/966,249.7 of its green ray, 2/083,372.1 of its blue light within an absolute degree of accuracy of 1 in 2,000,000. Thus the absolute length of the French meter has been determined by light waves, so if it be ever lost or destroyed we can restore it. The length of the English and American inch, foot, yard, etc., have not been thus determined, but it can be done.

By careful laboratory experiments light's velocity was found to be 186,500 miles a second. Eclipses of Jupiter's satellites and of the moon, the transits of Venus and other celestial phenomena were examined, and in every case the velocity and laws of light both in the heavens and on earth were found to be identical. Light, like gravity, diminishes according to the inverse ratio of the square of the distance. The different velocities of its beats, or waves, in a second, cause colors. Passing through transparent bodies, as glass, water, etc., at an angle, the ray is turned aside. The light-waves passing through dense materials become slower, and that is why the colors appear. Falling on objects the colored rays are reflected to your eye, and this is why you see colored objects. These light-rays follow fixed laws, obey mathematics. These figures never change. We know just how light will act passing through, or reflected from any object. Who is this Mathematician who gave light its laws, keeps it in its flight through space, and through these materials?

Will you say light was always here, and these laws and mathematics are eternal in duration? But when you turn on your electric light, light your lamp, or a fire, the light they give was not always; yet this light also follows the same laws and the same figures as the

light of the sun and stars. Light, like heat, is a mode of motion.

Light, heat, electricity, are waves of ether, and through this waving ether they come from sun and stars to earth. Heat is a vibration of ether in the heated object; increase its heat and it gives light. Movement, light and heat can be changed into each other and into electricity. One kind of an ether wave beating from 100 to 400 trillions a second is heat. When the beats, or waves, are 440 trillions a second the hot object gives out a red light. When the waves tremble 500 trillions the light is orange; 532 trillions, the light is green; 590, it is blue; 691, it is indigo; 789, it is violet. Beyond 789 trillions of beats in a second we cannot see the light, for these waves are too rapid for our eyes. But these rays print on the photograph, and we are in the region of X and other invisible rays.

These waves or beats of ether pulsate not back and forth like sound beats, but across the line of light, up and down like ocean waves. Stop and think of that swiftness from 400 to 789 trillions a second. Here we are in ether, a mysterious something on the borders of nothingness, from which the Creator made matter, when he added to it force, energy, when from the union of ether and force the metals and all matter sprang at creation. Greater is the wonder, For every eye of animal and of man has a retina on which these beats of light pulsate so they see. Highest of the senses, the eye looks out on nature and receives the pulsations of light coming with this swiftness which seems unbelievable. But this science proves.

Wonders pile up. From millions of stars and suns, from gas, and candle, and electric light, stream out these light-rays. From farthest confines of the universe light thus ever streams out of myriads of suns in everlasting silence. The choirs of the Eternal are ever singing silent songs of His Almighty Power. What is music but regular beats of musical instruments

and of vocal chords in human throats? Every beat must be regular, according to mathematics, or you will have discord. But every light-ray is regulated by the strictest arithmetics, decreasing in intensity according to the inverse ratio of the distance of the light-giving object. No one can change the beats of ether or take out a beat or pulsation here and there, for light is founded on the figures of the eternal Mathematician.

White light is composed of the seven primary colors mingled together—red, orange, yellow, green, blue, indigo and violet. Light falling on an object breaks into two parts. Some rays penetrate the object and are lost, the other rays are reflected—that is, thrown off—and entering the eye cause sight. But objects differ in their activities. Some reflect all the rays of light and are white, others absorb all the rays and are black, more absorb some rays and reflect the others and are colored. When a thing absorbs all the rays and reflect only the red ray, it is red. The leaves of plants absorb all the rays which they use in growth and life functions and reflect only the green rays, hence they are green. A blue thing absorbs all the rays but the blue. So it is with all colored objects. Therefore color is not exactly in the objects, but in the rays of light they absorb or reflect to the eye.

At the back of the eye of man and higher animals is the retina composed of 9 layers of living materials we will describe later. This delicate organ receives these different rays of light coming in beats trillions of times a second. These rays form images of the thing seen, so we see the object in its image. The eye is most wonderfully made to receive these light rays. How could blind unreasoning nature or any living being on earth make an eye so well adapted to receive these rays and form with them an image on the retina? Some Power, most learned in optics, chemistry and all the sciences must have arranged the laws of light and the materials of the eye so we can see.

Certain materials as glass, water, etc., have the ether so disposed in them that they allow light to pass through them without disturbing the rays, and we call them transparent objects. We can see through them. But the light-waves passing through are turned in their flight when the surfaces are not parallel, as in lenses and magnifying glasses in which the light is bent. For example, when you put the end of a stick down into water, it seems bent at the surface of the water because light does not pass through water as easily as through air. We take advantage of this law in making magnifying glasses, telescopes and optical instruments. The science treating of the laws of light is called optics.

You may ask why light can pass through some hard dense materials as glass and the gases. The structure of these materials is such that it agrees with the wave lengths. Objects through which light cannot pass, called opaque, have an irregular structure, which breaks up the regularity of the light-waves and therefore we cannot see through them.

When light passes through glass or other transparent substances its rapid flight is hindered, and the thicker the material the more it is retarded, till if it be very thick the light is all or partly stopped and it looks black or colored. But if the material be in the shape of a wedge, the light is bent out of its straight line, and you see the colors of the rainbow. Some light-rays flow faster than the others, and are not so bent. Through this wedge-shaped prism you see the colored rays—red, orange, yellow, green, blue, indigo and violet. The dewdrop, diamond, a broken piece of glass, etc., show you these colors. Newton first made a study of the subject. Fine microscopic lines drawn parallel also give the colors. Later scientists took up the subject and produced the spectroscope. But the foundations of this instrument were revealed from the Flood.

What more beautiful sight than the rainbow in the

cloud? From far-off days of the first rains it appeared in the sky. But after the Flood, God called the attention of Noe, second father of our race, to the beautiful sight. Before science advanced men did not know how to read the lesson the Creator gave. In the rainbow the seven primary colors of white light falling on fine rain-drops, are reflected back as in a wonderful spectroscope. There God gave the key which unlocks the mysteries of the whole material universe. This instrument reveals the wonders of the sun and stars, opens out vast fields to science and shows the materials of which the heavenly orbs are made. No instrument ever made is equal to the spectroscope, and that is the reason the Creator called men's attention to its powers.

"I will set my bow in the clouds, and it shall be the sign of a covenant between me and the earth. And when I shall cover the sky with clouds, my bow shall appear in the clouds; and I will remember my covenant with you, and with every living soul that beareth flesh, and there shall be no more waters of a flood to destroy all flesh. And God said to Noe, This shall be the sign of the covenant, which I have established between me and all flesh upon the earth."—Gen. ix. 14–17.

The Hebrew word here translated God is Memra; Greek Logos, Latin Verbum English Word, Wisdom—God's Son. Let us see if there be any wisdom, science, secrets, or learning hidden in the rainbow, first hint of the spectroscope.

We take metals and gases of our earth, heat them from the lowest temperature at which they get red-hot, and subject them to different degrees of heat up to the highest we can get in the electric furnace. As we increase the heat we examine the light with the spectroscope, and note the lines scattered amid the different colors of the rainbow. We do this for any metal or gas, then study, record and map the changes. Then we treat other metals the same way. In this manner we minutely examine every metal and gas of our earth as well as the different combinations of

metals and gases. In this way we find the colors and lines shown by every material of our earth when subject to different degrees of heat.

Each metal shows its own peculiar lines in the spectroscope, each gas its proper bands, and the hotter they are the more they will extend out at the violet end. The lines and bands are up and down at right angles to the colored band of light. The smallest particle of a metal invisible through the finest microscope or the most minute quantity of gas or chemical analysis will show its lines or bands. Here is the most wonderful instrument man ever made. It is called the spectroscope, "to see images," : the colored band is named the spectrum, "an image" ; the plural is spectra, "images."

Now we turn it to the sun. Curious black lines cross the horizontal band up and down; in some cases they are wide apart, in other places they are crowded together. For a long time the meanings of these lines were not understood. They were accidentally discovered by Fraunhofer in 1823, using a little glass prism. But when he fixed the prism before a telescope with a 4-inch objective lens, he saw many more lines. Learned men took up the discovery, heated different materials, found each metal gave out different lines, not always black like those found in the sun, but bright, and they were in the very same places as the dark lines of sunlight. These dark lines are caused by the intensely heated metal vapors in the sun which absorbed the light passing through them.

A metal heated so it becomes vapor absorbs or destroys the very same rays of light it gives out when a beam of light from any other source is passed through it. With the spectroscope we examine different glowing metals in a vapor state and map out their lines. Then we turn the instrument to the sun and stars, and find the metals and materials composing the heavenly bodies. If we could reach out our hand to the stars, and take a part of their substances and

by ordinary chemistry analyze these materials, we would not have as complete and perfect a knowledge of the composition of the minerals on them as this wonderful instrument gives us. No chemistry can equal this.

A mass of incandescent hydrogen glowing with its own light, through this instrument gives only four lines, red, bluish-green, blue and violet, instead of a continued band. Sodium gives only the well-known D line in the yellow, while iron has 160 lines ranging from the red to blue. Thus every metal has its own peculiar lines and bands. Take any material and heat it till it becomes a gas, and you will find its lines, but with them also appear the lines of sodium, one of the elements of common salt, which is so diffused through nature as to be found everywhere.

Get an iron pipe, say 5 feet long, place absolutely clean sodium in it, close both ends with glass, and expose the pipe to the heat of a furnace. Place an electric light at one end and the spectroscope at the other, so the light will pass through the sodium vapor, and you will see two black sodium lines imposed on the carbon lines of the electric light given out by the carbons. Measure these two black lines, fix their places in the band. Then turn your instrument to the sun, and you will see the very same two black lines. This shows that sodium in a state of vapor exists in the glowing atmosphere of the sun. We do the same with all the materials of earth, and find the same identical metals in the sun and stars.

Thus we find glowing with fierce heat on the surface of our sun, magnesium, iron, calcium, nickel, aluminum, sodium, hydrogen, helium and the various other metals and gases of earth. We see also that these materials are not all in the same place on the surface of our king of day; for the heavier are down deep, and the lighter metals float high over his surface. The sun's surface is composed of glowing metals in a state of intense heat, which vaporizes every one of them; a

vast atmosphere of hydrogen surrounds him, higher up is helium, lighter than hydrogen, and then comes the corona, the composition of which we do not know.

After Fraunhofer came Kirchoff, who improved the wonderful instrument, he was followed by Huggins, Rutherford and others to whom all honors are due. Then in the Pope's observatory at the Vatican, Father Secchi turned the spectroscope to the whole starry heavens. He found all the planets gave out the very same lines as the sun, because they shine by his reflected light. But the fixed stars told a different story. For each gives out its own peculiar bands and lines, showing that each star is composed of different materials, in diverse quantities and combinations.

The spectroscope turned to the stars opened up a field of discovery vast as the universe. It proved materials of which suns, and stars, and all the heavenly bodies are composed are identical with the metals we find on earth. It shows the very same laws rule the heavenly bodies as our world. Matter is the very same throughout the universe. On earth we find less than a hundred elements or different primary minerals, already half of these are found in the sun, and nearly as many in the stars. The time will come when every mineral of earth will be discovered in the stars.

This conquest of mind over matter in so short a time is wonderful. We can find one of these primeval elements of which worlds are composed only when it is on the surface of a sun or star, or when it floats as an incandescent mineral vapor near their surface. Many of the heavier metals as gold, platinum, lead, etc., are so heavy they never come near these fiery star surfaces, for their weight keeps them down beneath in the interior.

Oxygen, without which no man or animal can live, was never found on the sun. But because it is so necessary for animal life, on earth it is the most abundant of all elementary substances.

Ancient Greeks rubbed amber, found it attracted

pieces of paper, and thus discovered electricity, so called from the Greek, *elektron*, "amber." Gradually a knowledge of this new mysterious force developed. Benjamin Franklin, that genius of the American revolution, suspected the lightning flash was electric, and when he brought the lightning from the sky with his kite he tapped one of the great forces of nature.

Europeans developed the science. Faraday searched out the laws of electricity flowing through wires. The Americans with their genius for invention and machinery applied these discoveries. Henry paved the path for Morse, who invented the telegraph; Bell, the telephone; and Marconi the wireless system which will in time unite the whole world in streams of trembling ether through air, sea and sky. The vast electric force passing from sun to earth and from star to star as well as light and heat has not yet been studied. We have hardly touched the vast force of electricity in the universe. What wonderful forces the Creator made for the use of mankind!

How electricity causes these actions we do not know. But along these lines it may be found that the weight of all things of earth and the attractions of the stars are caused by the ether.

Heat, electricity, and light, are wave motions in the ether, traveling 186,500 miles a second through the ether filling all matter and the spaces between the stars. But it does not pass through metals with the same velocity and some metals prevent entirely or retard its passage. Some metals let heat through them, others pass but a part of the heat-rays. Electricity passes through a silver wire with almost the velocity of light, but the metal is too costly, and copper wires, which allow it to pass through freely, are used almost entirely in dynamos, electric instruments and sometimes for telegraph and telephone service. Light passes freely through glass, crystals and many other substances, while electricity cannot pass through glass, silk and other materials. Why this is we do not

know except that the ether in these substances takes on peculiar forms.

Electricity is taking the place of steam, running our railroads, moving our machinery, lighting and warming our homes. We have only began to tap that vast storehouse of force coming from the sun's energy. And that sun is a vast storehouse of light, heat and electricity, the result of that movement the Spirit of God gave matter when He moved over the primeval matter the Eternal made diffused in space. Thus every movement of nature—of star, sun, planet, wind, water, life, can be traced back through nature's laws till we find it came from the primordial Mover, God. How little we think that every movement we make, every change in nature, the moves of every living thing came from God, who moved over matter and gave it these forces. Thus, under these wise laws, nature is like a vast clock wound up, and going on, ticking out through creatures the force the Almighty impressed on the universe. If there were no Mover from the beginning, no motion would be now, no revolution of star, no season, no life —nothing but death.

Two clocks with pendulums beating seconds stand beside the wall keeping sun time in the National Observatory, Georgetown, D. C. Each tick they connect with a series of instruments, which at noon each day send out the time through the wires of the Western Union, Postal Telegraph, Bell Telephone, an opposition Telephone and the Washington Fire Department. "We sent the time once to the Lick Observatory, Mt. Hamilton, California. We carefully prepared, knew the exact time of both Institutions and found it took less than the 500ths parts of a second for the electricity to pass through the wires nearly 3,000 miles," said Professor Hayden.

Three and a quarter minutes before noon each day, the clock is connected with all the wires of the country, all business is suspended for the time being, and the warnings are sent out automatically by the clock with

a toothed wheel behind the second wheel. Tick, tick, go the instruments in every office throughout the whole country. In the final hundredths of a second of the noon hour at Washington, the tooth of the minute wheel touches a spring which closes the circuit, the announcement is flashed to every office in every city. The flow of the current releases the time-balls which have been hoisted to the top of the poles in the great cities. It takes only one-fifth of a second to travel from Washington to San Francisco where it is 9 A.M., the delay being caused by the relays.

The country is divided into belts running north and south, called Eastern, Central, Mountain, and Western time, each being an hour slower than the adjoining eastern belt. At present more than 75,000 clocks are connected with the timepieces at Washington, and these regulate our timepieces. The railroads are run according to this time, for a difference even of a few seconds between the engineers' watches might result in collisions and death to passengers. At 11.59 of Dec. 31, at the last moment of the dying year, the time is sent around the whole world, traveling over land and under seas through lines over 1,180,000 miles, making the journey in ten seconds.

CHAPTER XIV—HOW THE PHYSICAL FORCES PREPARED OUR WORLD FOR LIVING ORGANISMS.

All physical forces, light, heat, electricity, etc., are modes of movement caused by weight, their origin and foundation. The orbs and their forces were built of mists, metallic clouds, dust-like fine matters and gases the Creator made from nothing and spread throughout the spaces between the stars, which condensed by weight into the orbs, causing heat.

If these materials had only attraction, or weight, they would have fallen together in straight lines into the densest parts. By the law of inertia matter remains where put till another force gives it impulse—movement. After giving an account of the creation of matter, the Hebrew text states, not as in our translation, but: "And the Spirit of God was moving over the waters." (Gen. i. 2). He was there moving while creation was going on; without that Power the metallic mists and gases called "waters" would have rested motionless in space. We find each orb has three forces—one round its axis, the other round its primary, and attraction. These three forces do not belong to the nature of matter, they must have come from a Mover who set the orbs whirling, after giving them weight. How hard it is to move a heavy mass! What Almighty Person set these millions of orbs going? One who says the finger of God is not shown here is not a scientist, is unreasonable, is a fool.

The universe is like a mighty clock, orbs parts of tremendous wheels, spokes are attractions, central orbs round which satellites and suns revolve like pinions; no solid parts unite orbs, no springs or weights keep going this tremendous machinery, all are poised on finest mathematical calculations; the mighty clock of

the universe without tick or stroke marks time, the duration of material things, while God, angel and human souls separated by death live in the eternal NOW, for no past or future are in heaven with God, but the ever present as before the world was.

When man makes and sets going a timepiece, he interferes not with it till it wants his care to wind or fix, thus the Eternal lets nature go on following the time movements, laws and end he marked out from creation—these matters, force and life we call secondary causes are kept going by the Cause of causes. Who says God cannot stop our world revolving, preserve nature while it stops as in days of Joshua, that he cannot interfere with laws of nature, perform a wonder we call a miracle? When we learn the power of the Almighty, that is unthinkable.

What man makes he can unmake; will God be deprived of the same perfection? will nature He made, the universe He set going, dictate terms to Him? Will a clock tell its maker he cannot stop its ticking? After making and bringing the universe to its perfection, God left nature to work out the end He proposed—man's use and benefit.

This universe was created and finished during six great epochs of time. Afterwards God did not create new materials or species; whence the account continues: "And on the seventh day God ended his work, which he had made, and he rested on the seventh day from all his work which he had done." Gen. ii. 2. Here the Hebrew word for work is *melakah*. But his holy Providence still overlooks, upholds, enforces laws and keeps going the mighty machine. John v. 17.

Other forces more astounding, mysterious, surpassing than weight, light, heat, or physical forces were wanted to perfect the universe—these were living principles, material organisms, ruled not by mathematics but by instinct in plant and animal, and by reason in man. Alone of all the orbs this little world was to be honored with life, image of life eternal in God. There-

fore a long and special preparation was required to prepare our earth that living beings might flourish on her surface. Let us see how the natural forces prepared the surface of our planet that plants, animals, and mankind might continue their species till mankind ends in that secret remote date known only to the Eternal.

Our world not exactly round, has the shape a fluid globe would have turning on its axis once a day—its equator bulges out, the shape it took when it was melted. If suddenly stopped it would break up and become a perfectly round sphere. It is 7,926 miles in diameter at the equator, 7,899 through the poles—the difference being about 28 miles. Weight makes waters flow down along its surface and they estimate the Mississippi runs up hill, the mouth is four feet higher than the source, being that much farther than its head-waters from the center of the earth.

When shining like a secondary sun, earth lost heat and light, a crust of hot rocks covered its surface, eons of ages passed and this crust got thicker. Interior lost heat and contracted; crusts became miles deep, these broke, bulged up, forming continents, long ridges of mountain ranges. Mighty volcanoes belched forth lava fire and flames from melted interior. Attraction of sun and moon caused mighty tides, cooling crusts rose and fell, some in the beginning miles high, later only a few feet, and cool rocky masses floated on fiery oceans as ice swims on water. Thus continents, oceans, plains, mountain ranges, hills, valleys and great plateaus were formed on granite foundations crystallized of melted world.

Experiments with pendulum and other instruments in various parts of the world show the outside crust of earth is not as dense as the interior, and some scientists think the interior of our world is not in a liquid form because of the enormous pressure.

Only after the surface of our world, during untold ages, had cooled, after the surface passed through mighty cataclysms of upheavals and destructive forces

permanent continents, lands, mountains, plains, and dales were made lasting. During these later times only plants and animals lived; they were killed in countless numbers, for we find their remains all over the world. The world was then building its surface for one kind of creature, man, who was created last to be the head of all, for he alone has reason. Will any one say Providence showed no wisdom when he postponed man's coming till his palace was ready to receive him—the world's king?

If man had been made before these ages of upheavals, millions would have been killed, mourning would fill the world. Earthquakes, volcanoes, floods, storms, lightnings we suffer from once in a while, give us a faint idea of the awful forces of nature which shaped our planet before man. Nature was not yet balanced. The atmosphere was filled with carbonic acid gas, the weather was so warm the waters now in oceans then floated in vast clouds, for the earth was giving out heat, and the atmosphere was filled with steam. When the earth cooled these waters fell down, washed salt from lands and ran into ocean deeps.

While seven salt water seas branch into bays, straits and smaller bodies, three great oceans cover 112,000,000 miles of earth's surface. The Pacific has 70,000,000 square miles, the Atlantic 25,000,000 and the Indian Ocean 17,000,000. These three are mostly under the equator, whence by ocean currents and winds they spread the heat to lands far north and south. Was there no design in thus shaping the surface of earth with these deep depressions holding these waters which modify the elimate ?

Numerous and careful observations of earthquakes which raged before man was created show they are now only local, and take their rise about 30 to 35 miles below the surface, consequently between the solid rocky crust and the melted interior. The disturbance gives rise to two series of vibrations—one in the solid crust, the other through the melted interior. The former is

more or less local, while the latter spread far and wide, even to the other side of the world. The tremors spread through the crust like waves on water when you throw in a stone, a velocity of about 3.7 miles a second, while through the melted interior they pass with the velocity of 6.2 miles a second, reaching the opposite side of the earth in 22 minutes.

The foundations of the house where these lines are being written rest on the rock underlying New York. While blasting for the tunnels under East River near-by, the house shook precisely like the houses in San Francisco during tremors, being precisely the same but not as long or severe. The conclusion forced on the writer is, that an earthquake is an explosion of gases down deep in the earth. These gases or melted materials burst with a force a thousand times greater than any explosion on the surface, as they flow from one place to another between the solid and melted rocks.

The high velocity proves that the tremors are propagated under conditions not found in any solids, and that the interior of the earth must be several times more rigid than steel. The pressure of the rocks increase as we descend, and at a depth of 42–1/2 miles they press with the weight of 20,000 atmospheres. Therefore the interior of the earth, although melted, has a greater density than any rocks on its surface. When the lava is shot up through volcanoes, the pressure is removed and it becomes a liquid till it cools.

Astronomy shows the mean density of the earth is 5–1/2 that of water, denser than any rock, hence the density of earth's interior must be greater, because of the weight it sustains of continents, seas and surface crust. The conclusions of Airy, Roche, Du Ligondes and others show, that a rotating mass of liquid like the earth becomes an oblate spheroid, flattened at its poles like the earth, its flatness depending on its materials, their densities, the velocity of rotation, and the force of gravity at its surface. The earth must

have been fluid to produce the shape it has. Du Ligondes shows that the heat developed in condensing is 108,000 calories for each kilogramme of its mass, and that now it is losing one calorie per kilogramme in 2,000,000 years. But in the beginning the loss of heat was very great, as the melted surface was exposed to the cold of the spaces between the stars, before the atmosphere and water fell to cover its surface and the rocks became solid. The earth has a vast reservoir of heat. Will the day come when we will use this tremendous power of heat stored up in our planet.

The oceans cover nearly three-quarters of the earth's surface—72 per cent of the earth is covered with water, and only 28 per cent is land. The average height of the land over sea level is 2,250 feet, the mean depth of the seas and oceans being 13,860 feet, thus the water surfaces are two and a half times that of the land. The average depth of ocean waters is more than six times the average height of the land, because the land for the most part stretches out as plains, valleys and plateaus, the high mountains covering but a comparatively small portion of the earth's surface. Although greatest depths of oceans about equal the height of the highest mountains, the oceans are wide, deep depressions, like enormous plains, covered with water deep enough to flood the highest mountains of America and Europe if placed on ocean floor, except the summits of one or two of them. The whole bulk of the oceans, even leaving out the shallow seas, is more than 13 times that of all the land above sea level.

If earth's surface were leveled so it would be a true sphere, the whole earth would be covered with water two miles deep. This shows that oceans and continents have not changed places during times after life was created, that plants and animals did not spread from one continent to another. No great continent could be raised up without a corresponding depression in some ocean, or there would be a vast hollow under the rising land into which the water would flow.

Few think of the influence of water on the climate. If we had plenty of water on land for all animals and plants, and no great oceans, it is certain vast and varied forms of living beings would not continue. Oceans produce two effects on the rainfall. Water slowly stores up latent heat more than almost any other material, which it gives out with equal slowness. The surface of oceans become heated during direct sunlight, becoming warm down several feet. The air has less power of storing up heat, so a pound of water will heat four pounds of air to the same degree. But as air is 770 times lighter than water, a cubic foot of water will heat more than 3,000 feet of air to the same temperature. Therefore the enormous surface of the oceans, especially in the tropics, warms the lower and denser portions of the atmosphere resting on it day and night. This hot air rises, other air sweeps in and causes winds; thus the warmth is carried to all parts of the world giving out this heat to plants, animals and man. Does this not show a design? for if it were not so, few living beings could exist.

It seems at first the much larger surface of earth covered with water compared to the land regions is a detriment. But if the case were reversed, if the continents were larger than the seas, most of the world would be desert. For little water would be evaporated from the land, hardly any from these deserts, and then rain would not fall. It is very probable that if the waters in the seas were carried away by a planet passing near us, or if these waters were annihilated, all that lives would die for want of water. There would be no rains, rivers, lakes, because these would dry up within a short time. The vast surfaces on which the sun shines, send into the air in the form of invisible vapor great quantities of water, which the winds carry over the lands where it falls in the form of rain, giving life.

Without water there can be no life, for it forms a very large part of everything which lives on earth. A man's body is three-fourths water, and this element

is found in certain proportions in every organism. Without it neither plant nor animal can exist, for they must drink at stated times. Water is far more necessary than food, and comes next to air. The sufferings caused by want of water in deserts are indescribable. The dry air absorbs the moisture of the body, causing first an intense thirst, and later the most awful tortures. Traveling through the Sahara desert of Africa, the writer, because of weakness caused by thirst could not keep up with the others. At a distance he saw a Bedouin tent and rode to it. A woman, clothed in the garb of Abraham's day, would hardly notice the "Christian dog." But when he showed her little son a coin he brought a vessel of warm brackish water. Never will he forget how well that almost filthy water tasted.

During the enormous geological times, when this world was being formed for man's residence, vast floods washed the surface of the world, mighty forces played over our earth, guided by the Force infinite in power, preparing for the last creature, man. They tore the rocks, they ground the gravel, they crushed the sand, they formed the soil, that plant and animal might live for mankind's use and benefit. See the sand and gravel banks, the soil now covering the earth's rocky foundations—look at the great plains stretching out, and learn the lesson of the influence of water on the world, which was to enter into everything and be the most important element of living organisms. Who says no Designer was here, presiding over the building of a world, making it ready for life?

Water must be present in such quantities, and so diffused in every part of the world so as to be taken in by living organisms. In deserts, where no water is found, no organism lives. Nothing is so bare, so dead, so repulsive, as these vast dry plains and hills and mountains, hot, bleak, dry, deserted appalling.

The atmosphere or air which living beings breathe

must also have several qualities. First, it must have a certain density, as a storer of heat coming from the sun, with oxygen, carbonic acid, and water in a state of vapor, in enough quantities to sustain life. We have seen how too great heat or cold destroys life. To regulate the sun's rays, the atmosphere must be dense; if not, the sun's heat would burn in the sunlight, and it would freeze in the shadows as we see on the moon. Therefore when this world was made, the gases forming the air were made by a far-seeing Creator, who destined the world later to be covered with life.

Air has a peculiar property of allowing the sunlight to pass through it down to earth it warms; the air acts like a blanket preventing the too rapid escape of the heat. If this were not so, the heat would be lost every night, and plant and animal would freeze before the dawn of another day. This is seen in high mountain altitudes, where the cold becomes greater the higher you ascend. Even in the tropics, snow lies on the ground on high mountain-tops all the year round, because the air is too thin to retain the heat. There the nights are very cold. At about 18,000 feet, the air has only half its density at sea level, and planet life ceases, for there reigns eternal frost. Whence, if our atmosphere had only half its density all waters would be frozen, ice and snow would cover the world; seas, lakes and rivers would be forever frozen solid and nothing could live. Does not this show design, the footprints of the primeval Cause who gave us all the air we have—not too much, not half as much; we have just what we want that we might live?

If the air were half as dense, water would rise twice as fast from the surfaces of the oceans. As the vapor rose it would soon freeze and fall on sea and land, causing everlasting winter. The cold would be so great and so long continued that life would cease. Even if by some accident a wandering planet passed near the earth and attracted a quarter of the air sur-

rounding the world, a large part of the surface of our planet would within a few months be a snow-and-ice-clad waste, and all the higher beings, including man, could not live. But the machinery of the universe was planned and hung on universal weight, so planets and suns revolve round each other forever, and no great body has ever struck the world since life was created. As we look over the universe, we find no sign of such a calamity ever threatening our world. All these things were foreseen and provided by Him who built the universe.

By a law of nature, the pure sweet water alone rises without the salt. Suppose salt were ruled by a law which would cause it to be evaporated with the water, salt rain would fall on the land and kill the vegetation. Vegetation will not flourish on alkali soils. Therefore a wise Providence gave laws to nature. Who but the Creator determined earth and the planets near our globe, as Mars and Venus, would have water, that their masses would be great enough to retain the oxygen, nitrogen and hydrogen of which air and water are composed, while the moon and other bodies have no water? These gases must have been created in the spaces near which the earth travels round the sun, fell on the earth, and attracted by earth they combined with mighty explosions to form the great abundance of the waters we find on earth.

If the earth's surface were a regular plain, not in places raised up into continents and mountains, plateaus, and islands, the waters would cover the whole globe nearly two miles deep. Now who formed these continents and highlands, as we find them now raised so high over the level of the seas, so living beings may exist on them? If continents were not thrown up, only the highest mountains would appear as small islands in an enormous ocean covering the whole world.

No explanation of the formation of the great continents is reasonable except that at a very late period

of the earth's formation, the moon, our satellite, far larger in proportion to its primary, our earth, than any other satellite in the solar system, was torn from the earth.

Starting down in the waters of the Atlantic under the equator, the Gulf Stream sweeps mid the West Indian Isles, comes up along the coast of Florida with the velocity of five miles an hour, flows a mighty ocean river a few miles to the east of our coast, and crosses the Atlantic, bringing the heat of the tropics to the northern shores of Europe. Without this flow of waters England would have the climate of Labrador, and Norway, etc., that of Greenland. A thousand currents we do not know flow in oceans, cooling heated lands, and warming otherwise cold regions, making life flourish in vast regions which without them would be deserts. These currents are caused by the positions of the continents, which if in any portion or part of the world's surface would make life impossible over the greater part of our planet. Will you say no Power presided over the formation of these continents, or that an accident placed them in these positions?

Suppose these continents were along the equator, and the great oceans round the poles. The waters of the northern and southern oceans would be always frozen, lands under a burning sun intensely heated, no ocean currents could flow north and south to modify the extremes of heat and cold. The polar waters would be frozen, lands under tropics burned up, little rain would fall, most lands would be vast deserts, and no fish could live in seas bound in everlasting fetters of frost and snow. How could living organisms exist in these extremes? Did no Providence shape the continents?

American continents stretch from almost the north pole to Cape Horn, the old continent from Siberia to the end of Africa. Our two greatest oceans, Atlantic and Pacific, stretch almost from pole to pole. The warm waters under the equator flow north and south

along the shores of the continents bringing their gentle heat to far north and to extreme south, tempering the cold of these regions, and cold streams flow far below the ocean surface to cool lands under tropics. The Japan current comes up from the Indian ocean, sweeps along the eastern shores of Asia, having equatorial motion from west to east, bathes the lands along Alaska, turns down south, giving Washington and Oregon a climate like that of the north of Europe and the British Isles, making California the richest fruit country in the world.

As the land rises and falls along sides of hills, mountains and vales, the higher we rise or lower we go heat changes, so we find the climate varies within short distances. If the surface of the earth was flat, we would have to travel many miles to find the same change of temperature we feel going up or down these slopes. If we draw a line along these side-hills, we find an equal climate winding along, and we can continue these lines for many miles. They are called isothermal, "equal heat," lines. We begin in a valley where the heat is great, ascend to the top of a high mountain covered with snow, and the changes of temperature will be the same as though we went from near the tropics to the frozen north. Thus within short distances most varied degrees of heat prevail, productions ranging from down near the tropics to the arctic zone. Thus the continents were thrown up high into the air, to give the varied productions of the different warm and cold regions within a few miles. Was there no Providence in this?

The oldest rocks on the face of the earth are found in the Adirondacks: "Bark Eaters," thus called from a tribe of Indians the Six Nations drove into these harsh rugged mountains where they had to live on bark of trees. The granites were crystallized into large forms, when the hot earth cooled slowly. Other and younger mountains are formed of softer rocks, their sides, torn by weather, slope. But the Adiron-

dacks are high and steep, offering the most picturesque scenery of the world. The mountains are sometimes as steep as the side of a house, rising thousands of feet in the air. Till 1854 these mountains were covered with great white pine forests, having enough timber to build all the cities of New England; but this year hunters set them on fire; it raged all summer, extending from the St. Lawrence to near Saratoga. Well the writer remembers the awful conflagrations which raged that year. For years the blackened stumps stood. Poplar, beech, birch, etc., took the place of the pines.

Looking at a globe or map of the world, imagine the ocean bottom rising up to join South America with Africa, or the latter with Australia, as some scientists think took place when plants and animals were distributed. While this upheaval happened, some other continent would have been depressed to fill the hollow in the deeps of the globe caused by the upheaval. A continent of the same size would be depressed below sea level, or the bottom of the ocean would fall to such an extent that the waters would flow into it and lower the sea level all over the world.

If the continents were thrown up from the bottom of the ocean, as many scientific men say who find that once they were under water, such changes would take place as would destroy all life in the world. For plants made to breathe air cannot live in water, or water-plants in air. The oceans then were deep depressions from the beginning, and with the exception of narrow belts around the continents, as far out as 6,000 feet of depth, no great changes have taken place in their bottoms since life began on earth, with the exception of a few volcanoes thrown up. The great continents then have been from the beginning of life fixed and stable.

The greatest change regarding life was made by the ice-caps coming down from the poles, before which these regions had warm, balmy climates at stated

epochs. We find three times these ice changes took place. First, in the remote Eocene period came down an ice-cap which afterwards receded; a warm climate came and melted them and years in millions passed. Then came the Permian ice-cap, for the second time covering the world round the poles, extending into the temperate zones. This melted, balmy weather prevailed for ages, then came the third ice-cap. We find its remains in sands, boulders, scratches on rocks, etc., from central New York, where the deep dip begins inclosing Ontario waters, west south of the great Lakes across the continent through Asia and the north of Europe. We find its remains or of the other ice-caps stretch across the south of South America, covering continents with ice and snow miles deep as to-day in Greenland.

We are now receding from the rigors of the last glacial grasp, how long after did man appear we cannot say. We are going away from this epoch of excessive cold. Winters are getting milder, summers cooler. Glaciers on Alps, Andes, Alaska, Grinnell Land, on mountains round the south pole, in all parts of the world, are getting smaller, slowly receding as we approach the heated regions round mighty Arcturus. As some say, we are now entering the mighty springtime of the 105,000 years of our revolution with our sun and his planets round this tremendous sun center of the universe.

Continents show sea deposits of geological ages covering their whole surfaces. All continents were once entirely covered with ocean waters and again raised up, and deep clays cover all the ocean bottoms. They offer complete series of rocks of all the geological epochs and remains of fresh water deposits. Great oceans have islands forced up by volcanic action or built up by corals, but not one of these islands shows any ancient stratified rocks, such as we find in continents, nor any land animals or plants belonging to the continents except those brought there within

historic times. Each continent has its own special plants and animals, many of them not being found on the other great divisions of the land, but most of these plants and animals can live on the other continents. Corn, tobacco, potatoes, etc., found in America, are now grown in many parts of the old world. The eucalyptus tree, native of Australia, flourishes in California and other warm regions. It would take too long to tell how man or nature transported plants and animals from one part of the world to another where now they flourish.

Oceans' bottoms have been explored, the materials brought up show that they were never raised up like continents. All continents have high mountains, some of their sides, formed of rocks, being very steep. But the ocean bottoms are vast plains, which would appear almost level if all the water were drained away. These ocean basins are so vast and wide, that no deposits from rivers or shores ever reach them, or could have filled their valleys. No waves disturb their surfaces below a few hundred feet. The bottoms are covered with ooze composed of diatomes and microscopic shells of animals living in the waters above. Below this covering the ocean floors are composed of clays peculiar only to ocean depths. These show that the oceans were never raised up to form continents.

It is hard for us to say how these deep depressions on the surface of our planet were made, except that God made the laws of nature so they formed the earth as we find it now. Air and water then in form of steam, partaking in the heat of the cooling earth, surrounded it as steam and dense clouds high up in the sky. This water fell and filled the deep ocean depressions.

All agree that before lowest living forms appeared, slowly rocks were worn away, by vast floods which washed earth's surface, rains fell in heavy floods, great oceans swept over the whole world, tearing down mountains, grinding stones into sand and gravel. In

seas, lakes and valleys debris were deposited to be again upheaved by internal forces. Then valleys and plains were carved from mountains and hills. Winds, waves, floods and rivers washed the earth, forming soils, sands, and gravels. Sand-banks, gravel beds, round stones, and little pebbles are seen all over earth's surface. The whole land is composed of these soils and beds. Without them vegetables could not grow, for plants cannot grow on rocks. They cannot send their roots down into solid stones, nor can solid rocks retain water. Wherever we dig, if we go deep enough we find the solid rock underlying the soil. Who but a wise Providence presided over the formation of the soils and thus prepared for living organisms which long after appeared on every part of the earth's surface ?

Many mountains show marks of floods and loftiest summits have stratified rocks formed by water. These often contain shells, bones of animals and forms of plants which lived in water or in air of these remote periods. The animals of this remote time belonged to species which long ago became extinct. Yet animal and plant lived, while mighty forces then sported over earth surfaces. Beyond this epoch we find no signs of living beings. This rapid glance at our world before man, shows that not all at once, but gradually. God made plants and animals of higher and higher kinds and species till at last he ended with the noblest kinds of vegetables and animals, which man required for his use and benefit. What was the use of creating these before there was a human race to use them! As the universe was made for man, after he came to take possession of his residence no other forms of life were made. No plant or animal of new kinds and species are now appearing. We can only change and modify species within certain limits. The six great epochs of creation ended. We are now in the seventh when no new creation is taking place.

The word for "day" in the original Hebrew, from Gen. i. 5, down through Genesis, is *yom*, meaning a day of twenty-four hours, a short period of time or an epoch of vast undetermined length. Learned men always looked on the days of Genesis, during which God made the world, as vast periods of time, and only little minds have understood this word to mean a day of twenty-four hours. In the words of the greatest mind of any age—St. Augustine: "What kind of days these were, it is very difficult, or even impossible, for us to say how long they were." De Civitate Dei, L. xi, Chap. VI. Every learned man looked on these six days of creation as vast epochs, during which the world of matter, the plants, the animals and man were made.

If these "days" of the Bible were of twenty-four hours each, the text would be "morning and evening were the same day." But each of the six days ends with these words: "And evening and morning" were after each day. But evening never comes before morning the same day. What does this mean?

Sts. Augustine, Thomas, and great writers say "evening" means the darkness of angelic minds, and morning "learning," as we say "he is a very enlightened man." The angels did not see the wonders of God's might, till he showed it to them in the creation and development of the universe. As the panorama of creation was unfolded before them during these six vast epochs, there was brought forth in each epoch a new creation, millions of suns, plants, animals and, lastly, man, they were taught the marvelous unknown power of the Creator. A part, led by their leader, Lucifer, "the Light-bearer," had fallen away, because he got what we call "a swelled head," rebelled and wanted to be adored in that time of angelic ignorance. From ignorance—"darkness," they passed in that heavenly university to knowledge, "morning." Their text-book was nature, each creature was a letter, each species a lesson, each physical power a chapter,

each department of mineral, vegetable, animal and mankind a book, through which they passed before they graduated with a better knowledge of the Almighty.

How could there be light before the sun? But other stars gave forth that light, and the objection some writers advance has no foundation. For take away sun and moon, and starlight still pours down on earth. The great ring-cluster, the Milky Way, we described with its condensed mass of millions of suns, during these long geological periods, when these suns were much warmer than now, poured down their light and heat on the earth. Again, the Bible text says plants were created before the sun and moon, Gen. v. 11–12. The climate of these geological epochs differed from that during the time after man appeared. This warm balmy climate covered the earth, even almost to the poles. Arcturus, and the suns of this central star-cluster poured their light and heat down on all parts of the world when they were brighter and hotter than now. For they have now lost most of the light and heat which sustained the rank vegetation of these epochs. These stars revolve in all directions round our earth, up to 90°, and warm the world on every side even to the poles, where plants flourished in far-off days before man.

What kept up the light and heat energies of these stars during these long periods, and what built up our sun with the enormous forces he poured out on the worlds? All around the star cluster, to which we belong, is a vacant space on all sides—a hollow void without matter. The matter which was once there fell into the suns and kept up their light and heat during these periods, when they beamed down on the earth before the sun was made. The remains of these materials still fall on earth in form of meteorites and shooting stars.

All geological evidence shows that conditions favorable to life prevailed during these vast epochs before man appeared, and there was no break in these long

ages but a greater raising or lowering temperature even round the poles. An abundant vegetation then extended far towards both poles, and animal life was equally abundant. Type after type of animal came forth according to the conditions required for his race, developed, then died out, and other higher types took their places. Great beasts then sported in waters mild and balmy under an almost tropical climate extending to the Arctic Circle. Some of these beasts were 12 to 40 feet long and weighed as many tons.

From earliest times man found fascination in the study of the earth's surface. Traditions come down among ancient races that the world was made during vast periods of time. Egyptians and East Indians saw Nile and Ganges pouring forth vast deposits into seas, building deltas. Men taking stones out of quarries and excavating in the soil found forms of former life. The laws of Manu ruling monasteries and convents almost since the Flood, in the first chapter states that alternating times of destruction and renovation existed in eternal succession through periods of thousands of years, during which creatures were brought forth. Ovid gives Pythagoras' doctrines of changes slowly going on modifying earth's surface. Aristotle sees interchanges between sea and land, and volcanoes and earthquakes, and speaks of what long epochs there must have been during the eternity of time which went before man. Strabo writes of lands rising up and being submerged.

But we will not go into the history of geology, "a discourse on the earth's surface." How this new science has progressed within the last few centuries! When we study the crust of our world we find the lowest rocks all of crystallized granite, which proves that once the whole world was a fluid mass of melted rock which slowly cooled. That granite is the foundation of our world, the primeval formation God built on which to rest his superstructures of hill, and mount, and plain, and vale. What wisdom is shown here! For what is

harder and more lasting than granite? If other rocks formed the foundations of our world, they might break under the weight of continents and even the buildings of our cities might be insecure or plunge us into the fiery interior of the earth.

We never find a trace of life in granite. For what could live in fiery heat of melted rocks? Then vast ages passed and the world cooled during these ages or epochs of time. First, the azoic, "without life," was followed by the eozoic, "the beginning of life," then came the paleozoic, "ancient life," the mesozoic, "middle life," and later the cenozoic, "recent life." How long these epochs lasted we do not know. Some estimate each at millions of years. The forms of life we find in primeval rocks are all of the lowest plants which could live in these ages when the world was cooling and giving out its balmy, gentle heat. The light of the vast ball of the sun shone out on earth before it had contracted to become a comparatively small body. The planets were then all hot,—the larger ones shining with their own light. Thus vegetation flourished before the sun and moon were made to shine by day and night as now.

Then followed periods of time, each millions of years' duration. Plants of higher orders were created. First came the Fossiliferous, in which water animals, as reptiles, fishes, and shell-fish of lowest forms appear. Then came the Mesozoic in which we find the first remains of land animals. Then the world passed into the Cenozoic, or Tertiary, in which the higher animals came forth. At last came man, creation's crown. Read the first chapter of Genesis and you will find that this exact order of creation is described. When Geology became a science, men took the day mentioned in Genesis to mean one of our ordinary days, and some rejected this account of creation. But as science advanced they found that Moses was taught by a Scientist wonderfully wise. In all literature there is not a page so deep, so scientific, so condensed, so wonderful as the first Bible chapter.

The more man advances in knowledge, the brighter and more marvelous seems that account. In the days of the childhood of our race the Creator revealed how he made the universe, and every discovery since has only confirmed that story. We have given but a few hints here and there, for to explain this chapter of the Bible would require a whole book going into every science known to mankind. Minds only who have a knowledge of one or two departments of science, doubt that account, so short, so deep, so majestic, written in days of deepest paganism. When all men worshipped gods, God revealed it to show that the universe was not eternal, but brought forth from nothing at His word.

Geologists do not agree as to the length of these six tremendous epochs while God was creating. Many think that from the time of the fossil-bearing rocks to our day, 200 millions of years passed. Professor Ramsay says of the low animal life of the Cambrian period, "In this earliest known varied life, we find no evidence of its having lived near the beginning of the zoological series . . . and the climates of seas and lands were of the very same kind as those the world enjoys at the present day." Professor Huxley held the same opinion regarding the vast times of these eons of ages. "It is almost appalling to reflect how far back in the Paleozoic times we must go before we arrive at that common stock from which the crocodiles, lizards, Ornithoscelida and Plesiosauria, which had attained so great a development in the Triassic epoch must have been derived." These men, holding the evolution theory of the development of life, were forced to go back to vast times to uphold their favorite theory.

The most learned physicists, declare our sun could not have existed as a light-giving body for so long a time. Lord Kelvin, greatest scientist of our day, says. "Now we have the irrefragable dynamics proving, that the whole life of our sun as a luminary is a very moderate number of million years, probably less than 50 million;

possibly between 50 and 100." All hold the sun is cooling, and that its life in the future will be much less than in the past. Lord Kelvin in another place declares that it has been giving light for not more than 20 millions of years, that it will continue to shine with same light not longer than about 5 or 6 million of years.

We see geology and physics contradict the theory of evolution which required such vast periods for the development of life. This forces us back again to the first traditions, to the original revelation, that God acting in nature brought these living creatures into being by His own direct power, and not through natural selection as held by some. In human history, as far back as we can go into prehistoric times, while man lived on earth, although a great many animals became extinct, there is no proof that any new animals came by evolution. Evolution took the world by storm, as any novelty will. But we cannot point to any new animal which has been developed, and his nature changed since history began. The beasts remain the same in size, shape, instinct, species and family like those which lived on earth since man was made.

Times are coming when many animals will become as extinct as those which lived during these vast periods before man appeared. Perhaps a few will be preserved in parks, cages, and preserves. The world was made for mankind, and he is overrunning the earth. Tame animals were made to be his servants, these he will preserve, for they are useful. How helpless each and every beast is in any contest with man! How easy it would be to kill the most powerful animal or to destroy every brute which lives! The whale and elephant are completely in our power. How would one of them survive a shot of one of our 12-inch cannons? How true these words said to all mankind in our first father and mother:

"And God blessed them, and God said to them, In crease and multiply and fill the earth, and subdue it, and rule over the fishes of the sea and the fowls of the

air, and all living creatures that move upon the earth. And God said, Behold I have given you every herb bearing seed upon the earth, and all trees that have in themselves seed of their own kind to be your meat. And to all beasts of the earth, and to every fowl of the air and to all that move on the earth, and wherein there is life, that you may have to feed on. And it was so done." Gen. i. 30.

Man is master of earth because God gave him this mastery. He did this because he made the world for him, and gave him reason, the image of his own eternal Reason. But for perhaps millions of years before he made him the Eternal was preparing this world for his habitation. Before the king comes to live in his capital, they build and prepare for him a palace in which he will reside. So during these long epochs God was preparing this world as man's residence.

While man lived on earth little important changes have taken place on its surface, for the palace is all built and made ready before the king comes. It was soon after the glacial period that man was made. Beyond that we find the Tertiary period, the great geologist Lyall calls the Pliocene, when all over the world appeared higher forms of animal and vegetable life, forerunners of those of our day. We go back into the next, called the Miocene age, when lower forms of life left their remains. Then America, Europe and Asia had a warmer climate, and mammals like those now living in the tropics, but of distinct species and families, lived far to the north and south near the poles. Still farther back we go into the Secondary, or Mesozoic age, where we find vast changes took place on earth when still lower forms of life existed. Then we go beyond it to the Primary or Paleozoic age, where the fossil remains show but simplest forms of life.

If we examine the surfaces of continents and islands over the whole world, we will hardly find a large plain exactly flat. From highest mountains to seashores, the land is diversified by hills, slopes, and plains. There

are few inclosed depressions from which the water cannot run and these form lakes and ponds. The surface of the earth could not have been better shaped than we find it for vegetation to flourish and furnish food for man and beast.

If large flat plains spread out like the surface of the oceans, they would be covered with water, which would kill most plants. They could be but partly drained. Sour grasses would grow, which would not furnish food for domestic animals, for these cannot live on marsh grasses. But over all the world its surface is so raised up and shaped and undulated that rain waters drain, and flow into rivers to be lost in the seas. The sides of hills and mountains grow plants which will not live on the plains. This arrangement produces far more diversified crops than if the whole surface of the land were all mountains or all plains. A thousand things show a wonderfully wise Mind presided over the formation of the world from the beginning of creation, He gave it laws which ruled our planet, and the materials of its mass so that they shaped it little by little during these long ages till it became a fitting residence for man.

The natural forces shaping our planet formed three great plains, Mesopotamia, "between the two rivers," Euphrates and Tigris, meaning, "Bursting sweet waters," and "the Arrow," because of its rapid current. These two rivers water the plains where mankind first lived after the Flood. The valley of the Amazon has the largest river in the world, its head-waters rising on eastern slopes of the Andes, draining nearly 2,500,000 square miles, with a mouth 150 miles wide. The central plains of North America, extending from the mouth of the Mississippi to Hudson's Bay, contains the great Lakes and are bounded on the east by the Appalachian ranges, or the Alleghanies, "rapid flowing waters," on the west by the Rocky Mountains—the larger and most fertile part being within the United States.

As the writer visited various countries of the world,

was in every State and city and almost every hamlet of the United States, during his twelve years of almost continual travel, a short description of the physical geography of this country may interest the reader. But we cannot enter into details—they would make many books. Did not Providence shape this great plain, richest in the world, within the temperate zone, having different climates, then give it into possession of the most enlightened, progressive combination of races born of Japhet, "Enlarging"? Did not an instinct of the Spirit induce them to proclaim religious freedom, the rights of man, bring forth the inventions and discoveries they gave mankind, proclaim the Monroe Doctrine—that they are also the sons of the noble Aryan race, equals of Europeans, that no nations can conquer any part of America? God works through the mighty movements of mankind as well as in nature.

The eastern part of our country has periodical rain and snow; the western part has periodic rains in winter, and six months of dry weather. Plants which can endure great dry heat, live in desert regions; transplant them from one region to another and they die. Who made these to live in such different climates unless God who shaped their natures?

Half across Texas, Colorado and Idaho begin the deserts—gradually merging into waterless plains, hills and mountains. After winter rains these plains are covered with desert plants, flowers bloom till air is oppressive with perfume; rivers are swollen with waters, in summer they are dry. The writer found the same conditions in Arabia and the Orient. But the Sahara of Africa, except a few oases, is dead, lifeless, appalling in desolation.

Passing through deserts you feel a silence brooding over nature. Plains stretch out before you, unclouded sun beams down on you, heat stifles you, sands yield under you, springs are few and far between; the desert air is so dry you do not suffer because of the evaporation

of fluids from your body. You must carry water or you die.

Through deserts, are ranges of hills, mountains of colored rocks, seeming near in the pure air, but miles away. You pass from one valley into another once filled with water, where lakes would be if rainfall were heavier.

Most desert lakes once held water; some fresh, others impregnated with salt washed out of alkali soil; others held borax, chlorides, etc., now useful; great beasts lived in geological times in these waters, their remains are found in soil and rock. Nearly all these lakes are now dry, but some still have a part of the ancient waters.

Fleeing from the north, perhaps children of the cliff-dwellers, a tribe of Indians, about 500 A. D., came to the shores of a lake in an inclosed valley 8,000 feet over the sea. Their oracle told them to found their city where they could see an omen. Then when they saw an eagle with a snake in its talons, on a rock in the lake, there in the waters they began to found their capital, they called Mexico after their chief god. As they had to wade in the waters building their houses, the neighboring tribes called them the Aztecs, "the Cranes." Thus the coat of arms of Mexico, inhabited by Christian descendants of the native Indians, is an eagle with a snake. Deserts stretch from the borders of Oregon almost to the City of Mexico; you will find remains of irrigation works, dykes, etc., built by these tribes long before Columbus landed in Cuba.

Lakes of desert regions are drying up. The Fayoum of the Sahara, the oases depressions, the valleys of Arabia, the Gobi desert in Asia, show former fertility. North of Reno, Nev., is a lake getting smaller. Salt Lake shows the ancient shores high on surrounding hills, on islands in the lake, its shores are now a mile away from where they washed when Mormons founded Salt Lake City.

Four great rivers drain the southern plains of North America—the St. Lawrence, Mississippi, Colorado, and

Columbia; the smaller streams are too numerous to describe.

From far north once covered by the great ice-caps which deposited sands and gravels, down deep through underground rivers seep waters of melted snows into great Lakes, holding more than half the fresh water on the surface of the earth. These "Inland Seas" offer most dangerous shipping of earth, for vessels cannot fly far before storms without running ashore. From highlands inclosing upper lakes the waters fall down the Niagara, "the sounding waters," into Ontario, "the great waters," then out to ocean through the St. Lawrence, the greatest river of pure spring waters on the surface of our globe. Sailing on these lakes you are out of sight of land for days; you can hardly believe you are not at sea till you taste the pure spring waters.

The Mississippi, "Father of waters," discovered by Father Hennepin, taking into account the Missouri, "the colored waters," is the longest river in the world. From St. Paul to St. Louis it has the most beautiful scenery of any river in the world, diversified with hill and plains, bluff and bank, grove and prairie, farm and forest, in bewildering beauty lining either bank. Below the latter city plains begin till south of Memphis, dykes line its western banks, built to keep the mighty flood from ruining farm and city. On the east the dykes begin a little below Baton Rouge, "the Red Stick," capital of Louisiana, a State rich as the Delta of the Nile, where cultivated, but not so historic.

Rising in the Green and Colorado rivers, the Colorado, "the colored," in ages past tore a trench through the sandstone colored mountains, south, let out the waters of a great inland sea, forming the Grand canyon of the Colorado, in places over 6,000 feet deep. Wild is the desolation of these rocks,—red, brown, yellow, black and of different colored strata, as you look down more than a mile. The hills and mountains are colored like Nebo, where Moses died, and the cliffs round the Dead Sea. The Colorado, not quite as large as the Nile, flows

entirely through deserts, piled mountains of sand in Arizona, and its waters and banks remind you of the famous river of Egypt.

The Columbia, 21 miles wide at its mouth, drains the northwestern part of our country. Great salmon, weighing from 30 to 40 lbs., ascend to its highest waters and run up the rivers of Alaska to spawn, going over 500 miles up, eating nothing, some never return. They are guided by instinct, the Creator's wisdom, so other fish may not eat their spawn. Noble trees line its banks. Portland is on one of its great branches, the Willamette, so deep is the river the largest ships can rest beside its docks. They built the city here because the floods in the great Columbia, two miles away, would interfere with the shipping.

As you pass through the tunnel on the Southern Pacific Railroad, going north from California, you look down 4,000 feet on Ashland, the first town in Oregon. There, perhaps, is the most magnificent prospect in the country. Here begins a valley covered with giant firs, and this tree belt extends up far into Alaska, where, near the Arctic zone, they grow but a few inches high. Dr. Hayes, the famous arctic explorer, told the writer the regions round the arctic circle have pines, birches, willows, etc., but a few inches high, with perfect trunks, limbs, leaves and seeds. These little trees of the same species as grow large in the temperate zones, are small round the polar regions because they have little light and heat. He said the wolves used to kill their dogs, steal their food and attack man but they took a terrible revenge. They smeared sharp knives with blood, stuck them up in the snow round their ice cabins, when the wolves and foxes licked the blood the cold benumbed their tongues, which were cut to ribbons, and every morning they were found dead in great numbers.

Starting from the Mississippi mouth to its source, you find belts of different cultivated plants overlapping each other. First comes the sugar belt—great plantations of sugar-cane, whereon planters become wealthy, for the

soil is exceedingly fertile. Then you come to the cotton belt, where two-thirds of the cotton of the world is raised. Then comes the corn belt where billions of bushels are produced. Then you find, farther north, the wheat belt, and lastly the oats belt, rye and hardy plants. Interspersed within these regions are the other plants and vegetables. Who will say Providence did not shape our world and make these rivers and plains and plants and beasts to serve mankind?

Deserts unwashed by rains contain the ancient fertility of soil, cultivation does not exhaust the soil if treated with rotation of crops. Palestine is still a "Land of milk and honey," the Jordan valley would be of surpassing richness if irrigated by waters melting from snows covering Lebanon, Egypt is as fertile as in days of the Pharaohs, the human race will never want for food as long as men live. Was there no God who shaped nature to thus serve us and supply us food?

You ask what is the most valuable metal in the world? Aluminum is the most valuable—pure clay is composed of about 90 per cent. of this metal, mixed with other materials, forming soil; without aluminum in soil plants would hardly grow. It is as light as a dry cedar stick, almost floats. When the vast floods tore rocks into sands they mixed aluminum and sands, and with this mixture formed soils. In deserts you see the low valleys covered with clay composed of aluminum washed down from mount, hill and vale; thus sands, gravels, formed soils mixed and mingled with clays. Suppose this aluminum, which when pure, looks like silver, were as heavy as the latter, or weighed as much as gold, little would ever be found on earth's surface; plants could not grow in pure sands or gravels, and plant-life would starve for want of food. Every metal has what we call its atomic weight, ruling its movements, all regulated by a Wisdom surpassing. Yet little minds, ignoramuses, will hold there is no God. If we would take each metal and gas in the world, follow its laws and forces we would find infinite Power gave each force which shaped this world for mankind. But this would take a whole book.

Remains of plants and animals similar to forms seen also in our coal mines, are found in Spitzbergen, Eastern Siberia, Alaska and cold regions round north and south poles where now only mosses, lichens, and little trees a few inches high now flourish during the short summers of light and heat. These prove that once a mild, gentle, balmy climate prevailed there. The air was laden with moisture and frost never prevailed. Currents of warm waters were wafted from down near the equator bathing these shores now frozen eight and nine months of the year. These countries once had a climate half tropical with abundance of moisture and all conditions required for plant life, for the continents were then different.

Tree trunks of species now extinct, such as the giant ferns, cycads, horse-tails and plants of tropical climes often stand erect with roots imbedded in the soil in which they grew. Leaves of poplars, maples, oaks, etc., are preserved in these northern coal measures as though gathered by a botanist. In these forests roamed mastodons, with coats of long yellow hair and great tusks. These tusks are so numerous the gathering of them employs many of the inhabitants, and their ivory is used extensively. Sometimes the body of a mastodon is found frozen in the ice, preserved intact since long before Adam lived. Marks of gentle wavelets washing the shores, breezes on the sands, rain-drops on the mud now turned to rocks of all periods, tell us the climate of these distinct days did not much differ from that of our day.

During the four seasons, many more varied and different species of plants and animals live than could, if there were only one or two seasons during the year. Have these seasons changed during the great ages before man was made? Has the earth's climate changed? During these epochs before man appeared, the area of life was much larger than now, and during the paleozoic and tertiary times extended far to the north within the Arctic Circle. We find the same conditions favorable to life prevailed far to the south within the Antarctic Circle.

The coal found in these regions indicate that vast forests of deciduous, evergreen trees, and numerous plants lived, amid which thrived great flocks of mastodons, cousins of the elephants. We find beds of coal and other indications proving that in remote ages the climate of the earth was more uniform than now. This can be explained by a slightly different distribution of water, seas, and oceans.

If we accept the account of the Flood, that most of the water in the oceans fell from the heavens and flowed into the deep ocean beds, we will have an easy solution of the great abundance of plant life which then flourished near the poles. The warm waters from the equator penetrated into various parts of the lands to the north and south near the poles as bays, straits, etc., bringing moisture and heat.

On the west coast of Greenland, 70° N. Lat., beautifully preserved fossil plants of the Cretaceous period have been found, such as oaks, beeches, poplars, planetrees, vines, walnuts, plums, chestnuts, sequoias, etc.,—137 species in all, showing it had a climate similar to the northern parts of the United States at present. Still farther north, in Spitzbergen, in N. Lat. 78° and 79°, similar plants are found but not so varied. On the east coasts of Greenland during the cretaceous period flourished ferns cycads, conifers, poplars, sassafras, andromedas, magnolias, myrtles, and plants now growing in the United States and in Central Europe. They prove that a mild temperate climate prevailed in these regions ages before the first man. The vast deposits of coal found in both north and south temperate regions indicate a most wonderful and flourishing flora of plant life. This coal is now vast storehouses of sunlight and heat stored up for man. But this coal is not found in the warm countries, where it is not wanted, but in the cold regions where our homes could not be warmed and our machinery run without it.

Going farther back to the Jurassic period, we find proofs of a mild climate in Eastern Siberia and in northern Norway. Remains of plants and great reptiles are

preserved in rocks of all parts of the world. Still farther back, in the Triassic period, we meet remains of plants, some like those growing now, but most of them became extinct after the ice-cap came down and buried them. But in the Carboniferous period flourished these vast forests of gigantic ferns, horse-tails, and primitive evergreen trees bearing seed cones. They are preserved in a most remarkable way in coal and rocks, and we can study them as though some one had left us a dried specimen of each plant which flourished in these long epochs before man appeared. Their structures show us that during these vast periods of time, the atmosphere was filled with carbonic acid gas, which the growing plants sifted out and condensed into the solid carbon which now we use as coal. We can condense this carbonic gas by great cold and enormous pressure. But as soon as these are taken away, the carbonic gas returns to its gaseous form. How do plants condense this carbonic gas at ordinary temperature? They have a power, a force above that of any mineral force, a living principle which has this power, for it is above the forces of the mineral.

The coal we dig from the ground shows us that the northern regions of America, Europe and Asia were once covered with vast forests of sequoia, the "giant trees" of California, with the Sequoia sempervirens, its cousin, and many other great trees and plants now extinct. The writer saw specimens of the first species which was growing, perhaps, in the days of Moses. The leaves are small, cover the little limbs like those of the Canadian cedar and end in a point. The second tree has leaves arranged like those of the locust, but closer and not so large, They are not as gigantic as the first mentioned tree.

When the ice-cap came down over the northern world it killed all these trees except in California, where it could not pass over the great mountain range of the Sierra Nevada.

SECTION IV.—THE WONDERS OF LIFE.

CHAPTER XV.—NATURE'S BEAUTIFUL BALANCES.

The earth's equator is not in the plane of the path it follows round the sun but inclines 23½ degrees, that is, the world is tilted over that much so that for six months the sun shines on the northern part of the earth and then on the other southern part causing summer and winter, unequal days and nights through the two frigid and temperate zones. Writers have not looked into the importance of this tilted position of the earth for the development of life. It was put this way by a far-seeing Cause.

All the planets are inclined, some more, others less, than the earth. Let us suppose the earth's axis running through the poles, like that of Uranus, were inclined 46½ degrees to the plane of its orbit round the sun, there would be no such winter, summer or seasons as we have now. Uranus is at one time many millions of miles nearer the sun, during its circuit. Winter would be six months of arctic night, and tremendous cold would prevail over half the globe. The cold of the interstellar space, 449 degrees F. below zero, would prevail half the year over half the earth. Every drop of water would turn to ice, seas and oceans would freeze to the very bottom, and nothing could live on earth. On the other half of the earth round the other pole pointing towards the sun, there would be a continuous day of six months, with the sun overhead pouring down his tremendous light and heat, would boil all the water, and turn it into

steam. This vapor, floating to the north and south would fall as snow covering the surface miles high. At the two equinoxes, "times of equal nights," the whole globe would enjoy equal day and night for about a month, before the long six-month day or night would begin again and end the freezing or boiling of six-months periods described above. Nothing could live on the earth, if she had been placed with her poles pointing, one directly to and the other away from the sun. Now who will say that by an accident the earth was placed the way she is?

Suppose earth's poles were exactly at right angles to the plane of her orbit round the sun. The whole earth's surface would then enjoy equal day and night, and receive the same amount of light and heat every day. There would be no seasons. The light and heat would diminish from the equator to the poles, which latter would be always dark, while the countries near the equator would be afflicted with torrid heat. Near the equator the intensely heated air would rise and float over the high regions to the north and south, where exposed to the awful cold of the spaces between the stars, it would get heavier, force the air near the surface to sweep towards the equator, causing in both the north and south hemispheres continual cold winds, snow, storms and blizzards, which would cover the earth almost to the equator with snow making life impossible. For the sun at each pole would be always on or close to the horizon, giving so little heat the seas would be always frozen down to deepest depths. The whole atmosphere would be so cold, that all the waters, even under the equator, would be frozen except perhaps a belt of a few hundred miles round the earth extending north and south of the equator. In this case it is very probable that nothing could live on our planet.

Suppose the earth turned on its axis, not in 24 hours, as now, but once a year—that is, showed only one side to the sun all the time as the moon to us. The side turned

towards the sun would be scorched with a heat like the blast of a furnace, for it would have everlasting day. The other side would be in perpetual darkness, and the cold of the spaces between the stars, about 449 degrees below zero, would prevail there all the time. The air on the heated side would become very light, rise and flow over into the dark regions. The cold air on the dark side would sweep over to the heated regions in tremendous blizzards freezing up the whole surface of the earth. Did these movements of the earth measuring days, nights, seasons and years come by accident, or did a Providence preside over the world when it received movement?

Let us suppose the days and nights were 50 or 100 hours long as some of the planets. A large part of the heat of the day is lost now at night in the cold between the stars to be restored the next day by the sun. The heat would become so overpowering during one of these long days that nothing could live, and during the long night the cold would freeze every living thing and turn to ice all the waters of the earth.

A great air ocean about 100 feet high called the atmosphere, from the Greek, athmos, "vapor," and sphaira, "sphere," surrounds earth and we live down at the bottom. No one ever went or ever will go to its top, for there the air is too rare to sustain life. Plant, animal, fish, and man live on air; without it, life functions would cease. Air must extend so high, to press so much on earth surface, to have the right density, that living forms may flourish, not only at sea surface, but up sides of high mountains, and elevated plateaus. Earth had to have just the mass of matter to attract the air, retain the atmosphere so it would not fly away into space. Oxygen and nitrogen, composing air, have low molecular rates of motion, so they are held to earth even when separated they rise to high altitudes. If they had not these laws guiding them, they would fly away into space, long ago our world would have been stripped of its atmosphere, and all

that live on earth would have died. Was there no Providence in this?

Mr. Stoney worked out this problem and proves that neither oxygen nor nitrogen composing air is ever lost into spaces between the stars from high surface of our air-ocean. He proves hydrogen, helium and lighter gases, when in pure states, rise to top of atmosphere and are lost in star spaces, because they have not weight enough to hold them within earth's attraction. Did not a wise Providence beautifully balance nature's laws so air would remain on earth?

Suppose earth were larger, had more mass, its attraction would be greater, it would hold free hydrogen as this gas envelopes the great suns oft combined with helium and lighter gases. When freed from earth, these gases would rise in our atmosphere and gather in great belts round earth. As plants gave out oxygen which would gather near-by, a flash of lightning would unite them with a tremendous explosion, tear to pieces the surface of our globe, pulverize mountains and kill all that live. To light a match would cause these gases to unite as though a ton of dynamite exploded, smashing houses to fragments. Did not Power eternal give these gases laws which rule nature, or will you say this came by accident?

As hydrogen becomes a liquid at 412° F. below zero, and the cold between the stars is about 449° F. below, perhaps it becomes a fluid at the top of the air, does not escape but falls to become again a gas. Still we are not sure. The cold of liquid air is 338° F. below zero, the interstellar spaces are warmer round the great suns, that of Neptune's orbit is estimated as 364° F. below.

Light, a mode of motion in ether, after passing through space, absolutely dry and bitterly cold interstellar regions, presses on earth's surface 75,000 tons. The sun varies its light and heat during cycles of 4, 11 and 35 years, so light and heat pressures vary. Our earth swings round the sun resting on nothing, heat

and light pushes it away all the time out farther from the sun. Left alone to this force earth would get out farther and farther from the sun, go round him slower and slower, and at last fly away into space. Our finest instruments, with millions of clocks, show the earth in her yearly swing round the sun has not varied a fraction of a second in a century. The sun heat must be much larger in pushing power than light force, both press always on the earth, pushing it out away from the sun. This shows that at least 150,000 tons of pressure is exerted on our earth all the time, and you know how easy it is to move a pendulum. Who is this living, thinking, powerful Person, who reaches out His mighty hand every moment, and keeps our earth from flying away into space under the forces of light and heat? There is a mystery here which can be explained only by admitting the existence of God.

Electricity from the sun acts always on the earth causing continual electric storms, upsetting our telegraphs, telephone and wireless systems. They tend to push and pull farther away and nearer to the sun our world floating in space, nothing stops it from swinging back and forth like a pendulum. But our finest instruments show it turns in just 24 hours and revolves round the sun in exactly a year. What prevents these electric storms, united to light and heat impulses, from driving our world away into space where light and nature's forces would be upset? A Power eternal in might keeps our earth in its path at the same distance from the sun.

Gentle reader, did you ever see a desert? If you did, you can imagine what the world would be without life. What causes vast regions of plain, sand, rock, and mountain to be so dry and desolate? These west winds sweeping over oceans, take up all the water they can carry. The hotter the air is, the more water it holds as unseen vapor. When cooled, the water falls in the form of rain, snow or dew. The winds, blowing over the Pacific, about 7,000 miles across, become

loaded with water as invisible vapor. These winds strike the American continent from Oregon to Chili, except the regions under and near the equator. The land is warmer than ocean, and the radiating heat from the soil heats the air so its waters do not fall as rain. If these regions were all level plains, the western half of the American continent would be dry deserts, similar to the great Sahara desert stretching across North Africa. But a Providence stepped in long ago, for a wonderfully progressive people, a great branch of the Arayn, "the noble," race were too ccupy this land.

Along the Pacific shores, some miles in, when the earth was forming, a mighty ridge was forced up, volcanic mountains piled up miles high, summits from 10,000 to 15,000 feet or more. In the north it is called the Sierra Nevada, "the snowy Saw"; in the south they are called the Andes—the latter being 4,500 miles long. The west winds rise over these mountain ranges into the high cold regions, which cools them and they drop the waters they carry in forms of snow and rain. Many a time the writer saw the white summits of the sierras of California from the hot plains of San Sacramento, "The Blessed Sacrament," and of the San Joachim plains, so named after Christ's grandfather. These summits are white with snows all the year round —the drifts being often 30 feet deep. This water of the melting snow flows down in irrigation ditches, and makes California, by nature, a desert, bloom and blossom above any country of the world. No climate on the face of the earth equals that of our southern Pacific coast. The first white men came long ago from Mexico, entered this State through a deep valley, lifeless and hot, branching from the lower Colorado River to the west. At the place called Salton, a part now irrigated by the Colorado, "the colored," 264 feet below the sea, the writer found the temperature, February 20, 94 degrees in the shade; in summer it rises to 157° F. So they called this place California, "the hot furnace," and the name was applied by the Spanish to what is

now the whole State. But only a few parts, of this deep plain; is irrigated that being now called the Imperial Valley. Death Valley, the Mohava Desert, etc., are hot. At San Diego, the temperature varies only 10 degrees a year. It rains nearly all over the whole State from fall to spring, but no rain ever falls during summer. These regions have only two seasons —the wet and dry.

The desert regions of Asia and Africa were settled before the dawn of history and little improvements were ever made. The Oriental races are stagnant, and live as they did in the days of Abraham. The Americans came to California and found desert wastes like Arabia. They brought water from the mountains, spread it over the deserts, and made them bloom and blossom far beyond any other part of the country. For these dry lands, not washed by frequent rains retained their primeval fertility. Was there no Providence to elevate these ranges of mountains—the Coast Range and the Sierra Nevada, the Andes—whence the west of the American continent is not burned up like the Sahara, that these Americans may later show the Orientals how to reclaim their deserts?

A few degrees within the tropics under the equator, the air, intensely heated by the direct rays of the sun, rises, and inrushes of colder air, produce rotary movements causing hurricanes and typhons. Sometimes they are very destructive, overturning the largest trees, leveling the strongest built houses, wrecking ships. Suppose the air were denser than it is, the winds would destroy all habitations over the world, and man could not live on our earth. Suppose the earth were nearer to the sun than it is, the heat would be so great these storms would rage whenever the wind blew. If our sun were larger than it is, the same would happen. These whirlpools in the atmosphere have their object. For they raise the dust from the earth into the high atmosphere, that

around each dust particle water may condense to fall as rain, giving life to the world.

The warmer the air the more water vapor it will carry. Often, passing through deserts, the writer saw dark clouds floating overhead dropping heavy rains. As the heavy rain came down through the heated air every drop evaporated before reaching the earth, because of the heat radiated from the burning sands. Rains fall on high mountain tops because there it is colder than in valleys. What a provision of God this is, because if rains fall on deserts they would be covered with verdure, and no dust would rise round which rain drops gather to cause rains!

Deserts can be crossed because the camels can go for days without drinking. They have a special stomach, which holds enough water to last them for many days. Down in the waterless deserts of Arabia the writer met a caravan of over 100 great dromedaries, great camels twice as large as those seen in shows. As they came along chewing the cud, and put their feet down on the soft sand, their toes spread out forming a large cushion so they would not sink, whereas a horse would sink to his fetlocks and soon tire. Camels and dromedaries have a hump on the back, some species have two, and they are nourished by the food thus stored up. Who will say these beasts were not made by Providence so men with them may cross deserts, for without these animals, men could not in early ages live in deserts where we find oases and fertile valleys.

The heat of the sun might be either too great or not enough. In deserts of Africa, Australia, Western America and in places in India, the soil sometimes becomes so hot it will cook an egg—coagulate the albumen, the foundation of animal organism. On the other hand, in Lat. 40°, on mountains 12,000 feet high it freezes every night and even during daytime in the shade. Both temperatures are hostile to life, and if continued over large surfaces nothing could live there. Heat increases and diminishes according to the square of the distance

from the heat-producing body. If the earth were only half its distance from the sun, the heat would be four times greater, if twice the distance away, only a fourth of the heat would fall on the world. Even at two-thirds the distance we would experience twice the heat now falling on our earth. In these cases the albumen and protoplasm, the foundations of living organisms, so sensitive to heat and cold, would be cooked or frozen.

If for a moment a man could live on the fiery surface of the sun, or find solid ground to rest on, he would weigh tons, his clothing about 200 lbs.; on Sirius or Aldebaran, if he could resist their terrific heat, he would be so heavy he would have to be moved with a giant crane; on any of the great suns his muscles would strip from his bones, and he would fall to pieces with his own weight. These suns, so great in mass, would hold a man with the grasp of a giant.

You say perhaps these suns have planets gyrating round them. No one ever saw them. If we could build a telescope, with a glass the diameter of the earth, and a tube as long as from here to the moon we would hardly see these planets with it.

The density of the atmosphere depends on the mass of a planet, and on the amount and weight of the gases composing this air. If our earth was only half as heavy, it would not hold the air, for attracted by the sun and other planets, the atmosphere would be stripped off, and our earth would be a dead planet like the moon, the asteroids and the satellites or moons of the greater planets.

The earth is at the proper distance from the sun for his heat to raise up the waters from land and ocean to form clouds and fall as rain. It has about the same climate in all places at the same distance from the equator. This regularity of climate is not found on any other planet.

These conditions favorable to life continued on earth during these long periods before man appeared. These

striking conditions which favored life are not found on any planet.

Some planets are too hot, others too cold. Some have no water, others too much, some no air, others too high and dense atmospheres. A thousand reasons founded on science prove that our earth alone has life. The writers who write regarding life on other heavenly bodies do not go deep into the nicely balanced natural forces required to sustain living organisms.

We are in the temperate zone of the solar system, neither too near nor too far from the sun—just in the right place for life to flourish. If the earth were created nearer or farther from the sun, life could not exist on earth. Who says the earth was not placed in its orbit just at the right place by that Power who foresaw life was to cover its surface, or that chance presided when it was sent gyrating at this distance from the sun?

The interior of our world is still intensely heated, the remains of these tremendous collisions of matters falling from the sky. A few yards below the surface a constant temperature is found, differing little from the mean temperature of the place. But as far as our borings and deep mines have gone, they show an increase of heat according to the depth. The heat in all places increases 1 degree for each 54 to 64 feet in depth, and this is the condition all over the world. When the rocks are the same the heat is constant. Following this, if we could go 43½ miles down, we would find a temperature of 3,632 degrees F. The researches of the United States Geological Survey prove that lava melts at 1,616 degrees F., and granite, felspar, quartz and such materials at between 2,624 and 3,227 degrees F. The conclusion is that all rocks are in a melted state down 45 miles under us. But the enormous pressure on these rocks keeps them in a state bordering in the plastic, partly solid condition.

Air is composed of oxygen and nitrogen gases with peculiar properties, and is mixed with carbonic gas—coal in a state of gas. Oxygen gives life to animals and

carbon to plants. These only have properties which sustain life. If the world were clothed by any other gases nothing would live. We find some stars surrounded by dense atmospheres of carbon, which is in every comet, other stars have vast envelopes of hydrogen, helium and other gases, or metals in a state of vapor. Suppose these composed our atmosphere, earth would not have life. Oxygen and nitrogen united chemically make air we breathe. Hydrogen and oxygen united make water. These unions take place according to laws ruled by figures. Suppose there were no Cause infinitely wise in figures, who presides over the union of these gases, we might have any kind of mixtures differing from air and water, or they might remain unmixed, and we would have nitrogen, oxygen, hydrogen, and carbonic gas with a number of other gases forming an atmosphere surrounding our earth in which nothing could live, no more than life could exist in a great gas tank. A Being wise and powerful presided over the creation of these gases, and gave them laws founded on mathematics they followed in their unions.

The atmosphere is loaded with moisture. Water in the form of invisible steam is always in the air. The hotter the air the more water it can carry. If you quickly cool the air in a room the water will fall like fine rain or frost on windows, walls and floors. This water is always rising from ocean, lake and river, earth, plant and animal. As the air rises with heat, it carries this water into the sky where the cold condenses it in the form of clouds, which rain it down to earth to sustain life. If the air had no water, or if it remained too hot, no rain would ever fall and all would die. If this water in the form of vapor was not always in the air, the water in the plants would dry up, and they would die when exposed to the direct rays of the sun.

Because of the great heat radiated from deserts, the lower part of the atmosphere over them is very hot, no rains fall there, and earth is bare and burning. But we have often seen dark clouds drop water over the

desert, which never reach the surface. You will see a great thunder-cloud over deserts showering down heavy rains which are dried up before they reach the earth, because of the great heat along the surface. If these deserts were covered with vegetation, the plants would turn the heat into growth and cool the air, and the rains would fall. For this reason only by irrigation ditches bringing water from rivers can the deserts be made to blossom. Desert soil is richer, and when watered, produces greater crops, than lands on which it rains. For these deserts have retained the ancient fertility of the soil. The rains washed out these rich materials during long ages and poured the food plants require through rivers into the ocean.

Carbonic gas, which is coal in vapor form, of which there are four parts in ten thousand parts of air, is the great reservoir, from which plants build up the greater part of their structures. It enters into the protoplasms and proteids, out of which living beings build their structures. This carbon, or coal in a state of gas, is absolutely required for plants, which breathe it in through the leaves, bark and roots. But breathed by an animal it is death, as oxygen the animal requires for life is death to the plant. You breathe air all the time. You take out of it the oxygen and breathe out carbon. Soon you sift out all the oxygen, and you fill your room with carbonic gas, and that is why you must ventilate your house. But if you have some plants in your room, they will purify the air for you, for they will sift out the carbon, and give in its place the oxygen you want for life.

One per cent. of carbonic acid can be breathed for a time, but more than this in the air soon produces suffocation, and if the air be not changed death follows. For these reasons the carbon and other gases in illuminating gas cause death. If the proportion of carbonic gas were diffused through the air in larger proportions than we find it, all animal life would be destroyed. But a wise Cause mixed it in just the right proportions for

life. Yet we find that the larger part of comets are made up of this carbonic gas, we find it in vast quantities in the sun and in many of the stars. If our earth had it in the same quantities as these heavenly bodies, our race would have died out soon after Adam was made. How beautifully the Creator disposed all things for man on earth.

The air is formed of oxygen and nitrogen mixed so nicely, so beautifully balanced, that if these were disturbed nothing could live. At first it would appear that the oxygen of the air is the sole element animal life wants, and that the other gases are of minor importance. But a little study shows that nitrogen dilutes the oxygen the animal breathes, whence oxygen may be called the very life of all animals. But no animal can live breathing pure oxygen, for it would stimulate them so they would soon die. In lung diseases and difficulties of breathing, pure oxygen is a help, but it serves only for a short time. The air is composed of oxygen and nitrogen mixed in the proportion proper for human and animal life. Who mixed it this way, but He who made all men and animals to live in this atmosphere?

Animal life depends for food on plants, and these must get the nitrogen from the ammonia carried down into the soil by rains, after it is formed in the air by electricity—by the lightning. There is but one part of ammonia to a million parts of air, yet on this small portion all plants and animals must live, for they cannot take into their systems the free nitrogen of the air. For ages man did not understand the meaning or the work of the lightning, which frees this nitrogen from the air by its flashes through the sky. Only in our age did man begin to understand electricity working in the world from dawn of creation, furnishing ammonia as food for plants.

The height of the air, its density, its composition of oxygen and nitrogen, the amount of water, composed of hydrogen and oxygen, the earth surface covered with such a large amount of water, are so arranged that if

these were disturbed in the slightest degree, life would cease. A Power made these materials, marked out their laws, and still presides over their movements and their changes, that life may continue.

The air is dense enough to take up fine dust which attracts water vapor round it to become rain-drops to fall on land to water it for plants. The air has just the right amount of oxygen for animals and man to breathe and burn up the carbonic acid in the blood. The air has the right density to blow over surfaces of seas and lakes and raise up the "white-caps," waves, to mingle the air with the water, that the fish may breathe this air, from it to get the oxygen to purify their blood. If there were more air it would enter the blood of living beings and kill them.

The eastern ends of the 6 tunnels under the East River, New York, 4 for the Pennsylvania Railroad, 2 for the Subway, came out near where these words are being written, and the writer made a careful study of the works. They had to keep a pressure of 35 lbs. to keep out the water. The writer went into the air-lock when the pressure was slowly turned on. The ear-drums pained as the pressure became greater. Holding the nose and swallowing till the air in the inner ear pressed the same by opening the Eustachian tube leading down into the throat relieved the pain. The noise in the ears then became greater, the voices of the men seemed louder, and far away, a change was felt over the whole body, things seemed strange, uncanny as though you were in a dream.

Men worked three hours at a time, rested outside three hours and then went into the air and worked the same time—making 6 hours a day. Only most robust men were allowed to work in the tubes, each was carefully examined by three physicians before being engaged. Under the 35 lbs. pressure the air was forced into the tissues of the body, the oxygen was absorbed leaving bubbles of nitrogen in arteries and veins and organs. Before going in or coming out the men had to stay for a

time in the "air-lock" like a great boiler, the pressure being gradually increased when they were going in diminished when coming out. They had another "lock" beside the physicians' office wherein the men waited when feeling unwell under air pressure till the nitrogen was absorbed by life functions. They call the troubles "the bends," and 28 men died of the trouble.

Suppose our earth were larger, our atmosphere higher, or had a different weight, we would be in the condition of these men. How would we live under these difficulties? Yet ignorant men say there is no God, that the world came by evolution or chance and accident presided over its creation.

The air is just high enough and weighs so it presses about 14 lbs. on each square inch, at sea level being 15 tons on the body of a man. The fluids within the body press out the same so they balance. Exhaust the air from any part of the body, great pain is felt, blood and fluids ooze out. The air pressure is exerted not on human but on every living organism made by a wise Creator with life functions to balance.

Air, the poorest conductor of heat, retains heat, but slowly giving it out to neighboring materials. The metals are good conductors of heat—that is, the heat spreads rapidly through their masses. Put your hand on a piece of metal; it feels cold although it is the very same temperature as the surrounding air, because the heat of your hand spreads through the whole metal cooling your flesh.

We clothe ourselves to keep warm. Not the clothes keep the heat of our bodies but the air they contain in the spaces of the woven textures. If our clothes are wet the water rapidly absorbs the heat, this water being in the spaces where air should be, wet garments are very cold and disagreeable because of the abstraction of the heat.

Why are woollen garments so much warmer than those of cotton, silk, linen, etc.? Put these materials under the microscope and you will see the difference. The

cotton fibers are smooth, the silk shining the flaxen long fibers split one from another. Wool, the hair of sheep, was made to keep the beast warm. Hair is composed of epithelium, a rind and marrow, the epithelium is in small plates overlapping each other giving the surface a scaly appearance. In these scales and different structures of hairs the air remains, keeping its heat. Animals living in cold climates have hair wonderfully adapted to keep the air in their furs, and they were made this way to stand the climate where the Creator made and put them.

Life cannot exist in high, cold, rare air. Therefore the tops of high mountains are bare. The higher we rise the colder it becomes. At about 20,000 feet, even in the tropics, even under the equator, the mountains are covered with everlasting snow and ice. A globe of cold air surrounds the world at this height under the equator, diminishing in height going north and south, till it reaches the earth's surface at the Arctic Circle in the north, and the Antarctic Circle round the south pole. Beyond these circles towards the poles nothing grows except a few mosses and lichens round the edges. If you go higher than this, the cold increases till on the high borders on limits of the air the cold of the space between the stars over 400 degrees below zero prevails.

Under and within this air globe only can life exist. Living organisms are confined to this very limited region on this earth alone. The air is dense and acts as a blanket, keeping the heat during the darkness of night which was poured down during sunshine. If the air were denser the heat would be too great and living beings would scorch. If the air were not so high, thinner, or made of gases having other properties, the cold would be too severe for life. Will you say these things were not regulated by a Power who foresaw these conditions and made the amount of air required, that life might flourish on our earth?

Winds are great tides in the atmosphere, caused by heat but also by the sun's and moon's attraction. We

cannot go to tops of the atmosphere and see these air tides rise hundreds of miles high twice a day, as we see the ocean tides rise so many feet along our ocean-shores. For this reason few have remarked this sun and moon attraction as a cause of the winds.

The sun's heat is the next chief cause. Around the equator is a vast belt more than a thousand miles wide, where the sun beats down almost from high zenith and heats the air. Being lighter than the cold air above, the hot air rises and floats over this cold heavier air, then sweeps towards either pole. Under the equator this heated air was moving with earth's rotation from west to east at the rate of more than 1,000 miles an hour. As it sweeps towards the poles it still preserves this movement. But the surface of the earth has not this velocity as you go north or south, and at the poles the movement of earth's rotation is nothing. The hot air losing its heat in the spaces between the stars gets heavier and falls down to the earth's surface, still having this movement towards the east. For this reason in the temperate zones north and south the winds are nearly always from the west. This is the reason that in this country, Europe, etc., the clouds rise mostly in the west and sweep towards the east bringing rain, to thirsty soil, and plant and animal and man. What would be the world without these rains? It would be nearly all a desert.

Particles of dust, so fine we cannot see them, float forever in the sky, giving it that beautiful blue color. Darken a room, let a ray of sunlight shine through and you will see the dust particles. Winds and air-currents raise this dust from land surfaces. This dust is swept up from roads, city streets, but especially from deserts. These desert regions, seeming blemishes on nature's face, as though the Almighty had forgotten to finish His work, have their place in the plans of the Almighty. For if there were no deserts there would be no rains and nothing could live without water.

Water, as unseen vapor, spread through the air, must have something round which to condense, or rain-drops

cannot gather in the sky, form clouds from which the rains, fall. Water vapor, unseen in the higher regions of the atmosphere, collect round these tiny dust particles and form rain-drops which fall to the thirsty land.

What are winds for? To bring clouds over lands that rains may fall, to mix oxygen given out by plants with carbonic acid as breathed out by animals and man. Plants have leaves as lungs, but no muscles to draw in air like animals. The microscope will show their breathing holes. If there were no winds, the oxygen would surround the leaves and smother them in a short time. Will you say all this came to pass by chance, that no Supreme Mind regulated these balances?

Dust causes rains to fall on all the land, giving life to the world. The rainfall is heavier and more frequent on mountains, hills and slopes, because there it is colder, sinks into the soil and flows along under the ground. There are more underground rivers than flow along the surface. This water, absorbed through the roots of plants, is carried up even to the leaves. How wonderful nature was made, how nicely things are balanced by a Power infinitely wise. Plants can grow only in soil. How was it made?

For ages mighty forces playing on our planet-surface tore rocks to pieces, ground sand, gravel and formed the soil. A thousand floods swept over surface of earth, leaving banks of sand and gravel, covering valleys, filling depressions, forming earth and soil. If this did not take place, the surface of the earth would have been one mass of rock like the moon, no plant could grow in rock, and no man could live on earth. Men sometimes say there was no flood, but all soils, sands and plains, show that not only one, but many mighty floods once swept over the whole surface of the earth to prepare it for life. Desert regions show best the sand banks, gravels and soils ground from rocks by the action of water!

Directly down on the regions round the equator the sun pours his heat, warming the air which rises spreading to north and south. Flowing over the top of the

atmosphere where exposed to the cold of the spaces between the stars, it loses its heat. As it flows over Siberia, Alaska and these cold regions it forces down the intensely cold air. This bitterly cold air sweeps down along the surface of the earth. Having part of the eastern sweep of the earth at the equator, the winds with the cold between the stars come down from the north causing " blizzards," snowstorms sweeping from the west over the eastern and southern parts of our country sometimes extending to Europe.

The heat of ocean waters remain about the same, the winds coming from the west in our latitude on eastern parts of oceans vary but little. But heat changes on the continents and cause variations in the winds. Whence few storms rage along western coasts of continents but prevail on eastern shores. The writer seldom saw " white cap " waves on the Pacific, " the Peaceful," on western shores of Europe, Africa, etc., where the winds are more regular and storms seldom rage.

By a wonderful provision of God more rains fall on land than on seas. For the cold winds from north and south polar regions sweep along ocean surfaces because they are cooler than the lands. Moving along ocean surfaces these cool winds push the hot air loaded with water so it rises up bringing their moisture, and float over the lands where their waters fall as rain.

The air currents have to rise into the cold regions to pass over mountain ranges. They drop more water on the western than on eastern slopes. If there were no mountains little rain would fall, and the world would be for the most part covered with deserts. More rain falls on mountains than on plains. For there it is wanted that trees, shrubs and vegetation may flourish, that the waters may flow down to percolate in hidden streams through the soil, and that plants may absorb it when the weather is dry. If this were not so all plants in the plain would die during dry weather. How wonderfully all these things have been foreseen for the farmers who raise all

we eat, who follow the original and most important industry of earth.

You find springs all over lands where rain falls. If you dig deep into the ground, you will find water pure and sweet. All this water came from the seas, was raised into the air by the sun's heat, and carried up into the high regions by these currents of air. You cannot see the water rising from the oceans for it is invisible steam. As it ascends it strikes the high cold regions, appears as clouds, which floating over the land, drop their waters, giving life to all that live. Why does it rain more on land than on the seas? Many experiments were carried out by the learned to find the causes of rains.

Forests exert a powerful influence on the climate. Countries and places covered with vast forests are always a number of degrees cooler than regions stripped of trees. The writer traveled through the great forests of northern Maine, Missouri, Michigan, Oregon, Canada, etc. Before he came to the great woods, although it was summer, he felt the cold. Growing plants use the light and heat of the sun which they change into growth. Thus they absorb the heat, changing its energy into life movement, this heat is lost in woods and the atmosphere is cooled. This is the reason it is always cooler in the shade of a living tree than in the shadow of a dead object.

As the forest cools the air, more copious rains fall on forest lands than where the vegetation has been destroyed. This is one of the reasons the American continent is warmer now in summer than when it was covered with forests. We have not been careful of our forests, and the time will come when lumber will be scarce and dear. The United States Government is taking measures to preserve the forests, especially those covering the head waters of our important rivers.

When the forests are destroyed floods sweep down. The dead leaves under a forest form a mold, or mulch, sometimes a number of feet deep, which retains the

water, and keeps the roots moist. It retains the rain-water which slowly percolates till it reaches the brooks and rivers. Streams flowing through forests flow all summer about the same amount of water after the melting of the snows in spring. We see how the Creator has balanced nature, and how dangerous it is to interfere with His arrangements.

Ride a railroad along a river from source to mouth, and you will be surprised how few springs flow into it. Yet it gets larger and larger as down you go. The rains spread over the soil, sink down till they meet the bed-rock underlying all soils. The waters flow along the lowest levels, without coming to the surface, except where they meet an obstruction or come out into a lower level when they appear as springs. At last they flow out into the bottom of the rivers where you do not see them. Thus the river receives water from every side, it grows larger, till at last it pours its flood into the ocean whence it came, raised up by the sun's heat. There is a continual circulation of water from sea surface to the lands bringing life. The slightest change of law of rising and flowing water would make the world a barren waste.

What a little thing a particle of dust is, floating in the air, yet without this dust rain would not condense in drops and fall on earth giving life to the world. We will suppose there were no deserts or volcanoes or city streets whence dust rises. The air loaded with moisture would deposit abundant dews every night. Except where the land was irrigated by canals bringing water from mountains, the world would be bare and desert, because the soil would be so heated during the day that plants would die. The sun's heat is spent in evaporating the rain-waters that keep the soil and atmosphere cool so plants can grow. Without the dust, waters rising from the surface of the seas would be carried every night up the mountain slopes into the colder regions, where they would fall on soil and rocks in great abundance, causing torrents every night. The air thus un-

loaded would be lighter, and rise higher, bringing another inrush of air from lower ocean surfaces. This continued would cause vast torrents to rush down the mountains and hills, tearing the soil, carrying it down into the valleys, and cutting deep ravines, as we see them in desert regions where the hills and mountains are high.

The slightest changes of dust and rains from what it is now would make the world unfit for life. If there were no dust no rain would fall, the air would be so loaded with moisture we could not breathe it and live, for its water would fill our lungs so we would smother.

If the air were half as dense, the winds would have only half their carrying power, and clouds, now high in the air, would lay along the fog covered ground, making it wet and cold all the time so plants could not grow. The sky, now beautiful blue, caused by the millions of dust particles, too small even to be seen in the microscope—this sky would be then inky black, we could see stars even in brightest daylight. This dust produced by active volcanoes and deserts, spaces once looked as being blots on nature's surface in the face of that Providence who regulates all things, is raised into the atmosphere for man's use and benefit.

If no winds blew and distributed this dust, soon all dust particles would fall to earth and we would have no rains. Tyndal found the air of a cellar under the Royal Institute closed for many months so free from dust that the path of an electric light passing through it could not be seen. Winds blow over earth in storms, gusts, gentle zephyrs, upwards, downwards in every direction, in countless whirls and eddies, scattering dust in all directions, raising it to the greatest heights of the atmosphere, when water condenses round each particle to fall as rain. If by chance a comet or heavenly body came near to earth, and by its attraction stripped our world of half its air, these winds would have only half their power to carry these waters from the seas, and life would cease over nearly all the world. But this never happened, nor

never will, for God marked out the paths of comets and heavenly bodies in their flight through space,

Summer sun beaming down on lands heats air and soil, dries up the waters into steam—water vapor we cannot see. The air becomes heated more and more as hours and days pass. The torrid heat, the burning light would soon kill all living beings. But One fixed his laws and placed his limits.

A current of air loaded with dust rises into high cold regions, round dust particles the cooled waters gather forming drops, a little cloud, no larger than a man's hand appears, grows larger as it comes over the horizon. The heat changes into electricity, the air which has lost its heat cannot hold its water, clouds rapidly forming cover the sky blotting out the sun, the darkening clouds, surcharged with rain-drops, cover a large section miles in extent, the heat becomes electric currents flowing to the dark clouds which rapidly cover the whole sky.

Now as the electricity flows to these thunder clouds from heated land and air, the clouds cannot hold it, the air losing its heat cannot hold its waters spread as water vapor, and the clouds become darker and more threatening. This force, a moment before heat, now electric, flashes from cloud to cloud, down to earth, and from earth to cloud, while rains fall in torrents to thirsty soil which would burn if this did not take place. Who says a wise Providence did not regulate the forces of nature that we might live and flourish?

While this lightning was in the cloud, it united elements of the air and produced ammonia, which the rains bring down and spread along the soil as food for plants. Many and varied also are the materials produced in the air this way, that plants and animals may live. But each rain-drop brought down a particle of dust, and that is why the air seems so pure after a rain. If this did not take place, soon the whole atmosphere would be filled with dust, which penetrating breathing pores in leaves of plants would clog them, and entering lungs of animals and of men would soon smother them. What a

wonderful piece of machinery, then, our atmosphere is! But we have only glanced at its wonders. To give all its details would fill many books. Who will say a divine Mind did not regulate its laws that man might live? If any change were made in even one of these laws, soon life would cease on earth. Because we do not know these wonders of our world, we do not think of Him who from creation, from far beyond the time man appeared on earth, made the earth's materials in space, made oxygen, hydrogen and nitrogen, and gave them laws under which uniting they formed all the air and water on the earth.

It is estimated 1,500,000,000 human beings now live on earth, and one person in five works. If four bushels of wheat in one lump would represent the amount of matter in the sun, one grain would typefy the bulk of earth; but the polar star is 20 times larger than our sun. If all the coal and oil of the world were burned at once it would not produce one billionth of the heat the sun sends out each moment. The average yearly rainfall all over the world is 40 inches, a fall of one inch on a mile square surface weighs 72,000 tons, so you can estimate the power of the sun falling on earth to raise up this water to fall as rain from clouds, say, 3,000 feet, most clouds being higher. Assisted by the moon the sun raises ocean tides 3 feet every 12 hours. It would take a steam engine of 200,000,000,000 horse-power to do this work.

CHAPTER XVI.—WHAT IS LIFE—THE WONDERS OF LIVING ORGANISMS.

Living organisms are more wonderful, complicated and mysterious than physical forces. We cannot see the living principles in themselves, for they are on the borders of spirit realms unseen by the senses.

From ancient days learned men tried to explain the nature of life, and here we give the sum and substances of their studies. We study the acts and operations of living beings, for these show the powers animating them. When we understand their operations, we will understand the living energy which gives rise to their acts.

A being acts according to its nature. Minerals act on other minerals outside themselves by attraction, repulsion, etc. But living organisms act on organs forming their structures. Mineral movement, therefore, is from without; life is movement from within. Life, therefore, is movement from within the organism; physical movement is on things without itself. When an organism cannot move itself we say it is dead—movement in this case means any kind of vital action.

Three great orders of living beings in this world move themselves—plants, animals, men. Plant movement is slow, hardly seen; animals move quicker, for they are higher developed than plants; mind, and will in man move with great quickness—too rapidly to begin with their study, therefore, we will first take up animal movement to study the nature of life.

A stone or a star cannot move itself. The law of inertia keeps matter moveless where placed; no sun or planet would move unless a Power outside itself set it in movement. Who gave the million suns and planets motion, but the Almighty Power? But a living or-

ganism moves its muscles, makes blood circulate, breathes, digests, grows, nourishes itself. This no mineral does. A living organism has, therefore, a power within itself different from mineral forces. An animal's body is composed of various materials, mixed, united in mysterious and complicated ways, differing from mineral mixtures—combined by a force within itself, which makes it one complete individual.

Metals left alone to their forces form round globes, as dew, rain-drop, or mighty orb of sky. But materials in an animal's body are built into cells, like little eggs inclosing protoplasm. Each cell under the microscope looks like a hollow ball inclosed by a membrane. Millions of these tiny cells, some hard, forming bones, others soft, composing yielding organs, form the animal's body.

Living tissues show these cells ever moving, changing, taking in and throwing out nourishing and worn-out materials. Lately we made lenses of crystal quartz which gather light rays beyond the violet rays, with which we photograph life functions glass lenses cannot show. With this instrument, we see life's functions; these prove the living force is a power not found in crude mineral matter. Long experiments of Pasteur, Tyndall, and famous scientists prove dead matter cannot produce life. Life comes only from life. Where did animals first come from? Science gives no reply. Let us go, then, to the Bible for that wonderful work gives the only answer to the riddle of life. First, plants were created, lived for untold ages as geology shows, then came animals, these words tell their origin:

"God said: Let the earth bring forth the living creature in its kind, cattle and creeping things, and beasts of the earth according to their kinds, and it was so done. And God made the beasts of the earth according to their kinds, and cattle, and every thing that creepeth on the earth after its kind. And God saw that it was good. And he said: Let us make man to our own image and likeness: and let him have dominion

over the fishes of the sea, and the fowls of the air, and the beasts, and the whole earth, and every creeping creature that moveth upon the earth." Gen. i. 24, 25, 26.

There is the only reasonable account of the beginning of beast and man which will satisfy any person learned in science. Theories of life coming up from dead matter, floating to earth from other heavenly bodies, are published by people half educated who drew on their imagination, who try to attract popularity, but in these they show their ignorance of the nature of life.

Take your microscope and examine living tissues of animal or human flesh, bone or organ. Millions of little cells, round microscopic chambers, all filled with protoplasm, compose the organism in which circulate air, oxygen, hydrogen, masses of solids, gases and vapors of minerals—during life, forever uniting, dissolving, building up, tearing down, burning up, and throwing out. A red river of life, the blood, circulates through all parts, its nourishing materials enter every cell, bringing to them serum, blocks of chalk, slabs of lime, masses of tartar, phosphates of lime, solutions of iron, materials of bone, particles of ash, strings of albumen—all to be built up into the structure. A force unseen reaches out, grasps the materials wanted in each place, and builds them here into flesh—there into bones; in one place nerves, in another a brain, in another an eye. All is harmony directed by an Intelligence infinitely wise in chemistry, hydraulics, mechanics, mathematics and all the sciences.

Life, therefore, is a force, a principle with the power of movement, created to animate an organism, to give its own life to the dead materials of which it builds its body. The living principle comes not from crude minerals of earth or star, but must have been created. Life was placed here by God, and living beings have propagated their race down to our day.

Plants differ from minerals in chemical structure, development, time of living, ways of preserving its life

and reproducing its species. A mineral may be broken in pieces; sand, gravel, stones may be formed into concrete by chemical actions; gold, iron or metals can be hammered into varied forms and they remain the same materials as before. Minerals become solid, liquid or gases according to their heat, and they are the very same.

You cannot do this with any living thing. Tear to pieces a living organism and you destroy its life. Living things must have the right heat, or they die; extremes of heat and cold kill anything which lives. They must have the right amount of light, heat, water, soil and air its species wants or they will die.

A living organism differs from a mineral in structure. In every part of a mineral you find the same structure throughout. Iron, silver, gold, etc., are the same no matter how finely they are divided. But in every living thing you find diverse structures, organs of various compositions made of different material. Bark is not the same as woody fiber, leaves differ from seeds, buds are not like limbs, skin differs from bones, brain from heart, veins from arteries, eye from ear. Yet the structure is one whole, all tend to one end, the perfection of the individual in growth, nutrition, and the bringing forth of another of the same species as itself.

Look at a tree. See the bark covering it like a skin, the woody fiber giving it strength, the pithy heart within, with its branching limbs. The spreading leaves are its lungs to breath out oxygen and take in carbonic gas, the roots are to suck up water, and all these work for the individual tree. It is one complete whole, not many trees. If you cut off one of its members the latter will die. If you strip off all the leaves, or all the roots, or all the bark, it will not live. Every member and organ is for the whole tree, not for itself, for the one life force animates, and spreads, and pervades the whole tree.

A mineral is whole and complete in itself. Thus copper, silver, iron and the hundred minerals of which the universe is composed are complete in themselves. These hundred minerals uniting form this world and

all the stars. But no living organism is ever composed of only one mineral. Every plant must have at least three substances—carbon, or coal, oxygen and hydrogen in the proportion of C_6, H_{10}, and O_5 which form cellulose. To these the animal adds nitrogen, but the proportions of animal organisms are by weight, C 50.4 O 24.67, H 6.64 with nitrogen 18.34. This is the composition of albumen, the foundations of animal organisms, combined with small parts of iron, sulphur, etc.

Materials of the mineral kingdom may be united by chemical action; they may be mixed together without chemical union to form a mass; but this cannot be done with living beings. For if you force strange materials into the body of a living being it will die. Mineral fibers may lay beside each other as in wire and wrought metals, in flakes as mica, in strata as in rocks. These may be separated and broken, and the minerals will remain the same materials. But nothing can be added to the body of a living thing except what it will take in a natural way, digest and assimilate into its own tissues. The mineral is passive, subject to external forces, while the living thing has within itself a force, acting according to its own nature, regulating its acts, not from without, but from within.

This living force is more powerful than the attractions of the minerals. Solidifying matter unites making the same structure through the mass, each mineral acting according to its laws. Two and more minerals may be united according to the mathematics of chemistry, and these different elements will be found in every part, as iron and carbon make steel, as different materials crystallize, as diverse metallic gases combine to form air, water, etc., ruled by the physical forces which control them.

But living organisms build their structures in spite of and contrary to these physical forces. For in place of putting the materials together intermixed, and side by side, the living force raises matter up in spite of weight and the physical forces, and puts there materials in the

form of little egg-shells we call cells, under the miscorscope looking like wonderful jewels as they flash forth the reflected light, colored in rainbow tints.

Cells of plants, fishes and cold-blooded organisms are white. Cells of warm-blooded animals and of man are red. Cells are placed side by side in strings like beads, ends touching, and building every muscle, bone, organ, fiber and part of living organism. In plants they make long woody tissues built into little pipes, ends touching and opening into one another, through which sap, the plant's blood, circulates. Structures of plants for the most part are lighter than water, whence wood floats, while animal cells are heavier and sink in water. By instinct every animal can swim, while man has to learn, for he must learn all he knows.

Minerals do nothing to develop their being, remaining the same till acted on by causes outside themselves. They never take other materials into their structure, digest and incorporate them into their own materials, or change their nature into their own bodies as the living organisms do in growth and nutrition. Minerals unite with other minerals. Iron uniting with oxygen rusts, but these two remain as before—the oxygen does not become iron. The plant takes in water, air, materials it wants as food, and changes these into its own organism. Under influence of light and heat the plant grows, sends out leaves, roots, buds, flowers, fruits and seeds. Having propagated its race it dies. The mineral does not die, for it is always dead and remains the same forever till another outside force changes it.

Minerals rest in the same place till changed by forces outside themselves. But a plant will push its roots down deep into the ground to get water; will shove the stones out of its way, will turn aside if the stone be too large, will take up water, lime, potash, silica, which tend to crystallize; will kill this crystallizing power; will build these materials up into its own tissues; will make use of and controls capillary attraction; will pump up water against the attraction of the earth; will control and turn

to its own end the chemical forces; will upset laws of flowing fluids in its pores; will give out oxygen; will breathe in carbon from the air; will with it build leaves and wood; will turn its leaves towards the sun for light and heat; will control every natural force and will shape to its own, growth, nutrition and the propagation of its species.

How could matter, dead, inert, crude, produce life? For a thing cannot give what it has not. Matter does not live, and how could it give life? Earth is dead. Rocks, sands, soils on its surface have no life. When from the fiery womb of nature our earth came forth it had no life. Then God said: "Let the earth bring forth the green herb, and such as may have seed, and the fruit tree, yielding fruit after its kind, which may have seed in itself upon the earth. And it was so done." Gen. i. 11.

Vegetables are the food of man and beast; therefore God first made them before he made animals and man. All we said regarding the vegetable life may be said, but in a higher degree, regarding animal and man. For man is a mineral in the materials of his body; a plant in his three functions of growth, nutrition and the reproduction of his race; an animal in all the animal functions of his body, and he is an angel in his mind and free will. The human body is the most wonderful chemical laboratory, the highest and most complete organism that lives.

We glory in our generation that we condensed with cold and pressure air and gases into liquids and solids. To do that we use tremendous pressures, with cold hundreds of degrees below zero. The moment they are removed the gases return to their original state. But plant, animal and man condense gases into liquids and solids and hold them in these states in their organisms. They do this without using either cold or pressure. Plants and animals of past ages sifted carbon coal in a state of gas from the air, condensed it in the form of coal in their structures. You put this coal or wood

in your fire where the heat turns it into gas which unites with the oxygen of the air and throws out heat to warm you and cook your dinner. Only living organisms can thus condense gases, and this alone shows life cannot come from dead matter but from a living germ.

Bathe plant organisms in nitric, sulphuric and other acids till they are on the point of dissolving into the gases composing them and you have gun cotton or nitro-glycerene, mixed with other materials made in other ways you have dynamite. The gases plants solidified in growth suddenly released tear asunder hardest rocks. Unite charcoal sulphur and nitre according to the formula $2KNO_3S3C$, in proportions, nitre 74.84, sulphur 11.84, charcoal 13.32, you have gunpowder. Put this or smokeless powder into the 16-inch cannon at Sandy Hook guarding New York, behind the great shell and fire the gun. The gases condensed and stored by the plants send the shell 16 miles to destroy a hostile ship, the moment it strikes, powder inside the shell, weighing a ton, explodes tearing the vessel to pieces. Who says plants have not a force living within them which controls physical forces?

Living principles have millions of powers unseen, which animate millions of cells composing each organism. There is a separate power for each cell, for every cell lives, when it dies it is a foreign body and must be thrown out.

Chemical combinations, separations and unions make many products of living organisms, as urea, indigo, quinine, etc., but they are as dead as the elements from which they were made. Life comes only from life, no minerals alone will produce life, for life is a superior force which came from God.

Minerals mixed under chemical laws, take wonderful forms in crystallizing, follow lines, obey mineral laws, trigonometry, geometry and the mathematics the eternal Mind imposed on matter. But every crystal is the same through its structure; the smallest crystal of sugar, salt, bromide of potash, etc., is the same through its whole

mass. But with few exceptions, in living structures the crystallizing powers of the minerals are controlled, and materials form in cells built in growth.

Organisms have three chief powers, growth, nutrition and reproduction. Growth, powerful in youth, stops when the individual gets its full form and strength, nutrition goes on till death. Before it died it brought forth others of its species to continue the race. The young resemble the parents in shape, organs and details of color, hair, feathers, teeth, claws, scales, spines, crests. The human race follows this law, for the sons of Sem, Ham, Japhet modified by climate, may be recognized in their children.

Protoplasm, "first formed," basis of life composed of nitrogen, hydrogen, oxygen and carbon spread through the universe enveloping millions of suns, compose all animal tissues, skin, bones, hair, horn, teeth, nails, saps, seeds, trunks and trees, woods and weeds, stalks and stems, flowers and ferns, fish and fowl. Human bodies are all composed of these four gases, mixed with iron, sulphur, silica and a few other metals. Gases are made solid, the minerals are dissolved in protoplasm, or by solvents separated from it, and by blood of beast and sap of plant carried to where wanted to be built into the living structure one and identical with the living force which directs movements. A wonderfully wise Intelligence presides over the building of a living organism.

As we start from the groundwork of growth, protoplasm, we find living organisms bring in other substances, as sulphur, iron, etc., and make proteids, most abundant in animal structures. These give nourishing properties to meat, cheese, eggs and animal foods, which alone can nourish some animals—meat-eating beasts. Guided by instinct these will eat only these animal products. A dog or cat will take meat before any other food, for they cannot or with difficulty assimilate vegetables. They eat nothing till they smell it, to see if it has these proteids. Smell tells them what is good, what

is useless or harmful, and they know that better than we. All through nature we find animal instincts, showing a wisdom wonderful to see, guiding them in all their acts for the preservation of the individual and the propagation of their race.

Oxygen is the food of protoplasm, without which it cannot exist. The wonderful peculiar but invisible structure of the protoplasm enables plants to suck up water through the roots, to absorb carbonic acid from the air, to separate the oxygen from it, and to throw it out for the animals. We cannot find out how it is done, for protoplasm defies exact chemical analysis, therefore we cannot find out its exact structure. Oxygen, hydrogen, and nitrogen, range side by side in the organisms more beautifully than the carved stones in a great Gothic cathedral. This is but the starting-point of these wondrous plants and animal and human bodies built up, each according to its kind and race.

The extreme mobility and liability of protoplasm to change enables the structure to be modified in constitution, form and figure, by the addition of other simpler metals to serve the purpose of the living principles, and with them build up these organisms, which grow into all the varied kinds of plants and animals and the human body. Who presides over this work? Who directs these buildings? Who is the Great Architect of these structures? Who stands by to see that each particle is placed in the right place? Man can build a great bridge, a structure beauteous of form, raise an edifice to hundreds of feet, with many stories; but with all our arts and learning we cannot make a blade of grass; all mankind together could not make a cell of the living organism.

Protoplasm has a power of absorbing and molding other elements in different parts of the living organisms for special use. While making this protoplasm, the foundation of the physical structure, the living principle grasps and brings in silica, deposits it in the stems of the grass family of plants, arranges lime in bones of

animals, dissolves iron in the blood, absorbs sulphur in the bird and phosphates in other organisms. In addition to the four elements—oxygen, hydrogen, coal and nitrogen—of protoplasm, many animals and plants have iron, sulphur, chlorine, calcium, sodium, potassium, calcium, magnesium etc, while in fewer cases we find fluorine, iodine, bromine, lithium, copper, manganese and aluminum, in special organs. These are carried by the protoplasmic fluids, built as wanted, and in the proper proportions, into the structures.

They are not tumbled in without order as you would dump a load of bricks and stones where you are going to build a house. They are built up, arranged, put together like stone and brick, end to end, as the builder puts deep foundations, iron pillars, wood and glass, windows and doors, walls and rooms, each in its own proper place, when he builds a house. Every organism had an Architect and a Builder infinitely wise, who planned and built the first living beings, and gave them power to give birth to others of the same kind.

What different kinds of odors, flavors, colors, textures, fibres, varied wood-roots and tubers, gums and oils, resins and saps, skins and hides, sugars and sweets, trees and shrubs, grains and grasses—in a word, all these numberless products of the vegetable and animal kingdoms, which render the world so varied, so diversified and which enter into arts, commerce, industry, and chemistry. The world of plant life is the foundation of all these. For without plants, animals or man could not live. All these things are wonders. We see them so often that we do not think of them. We do not put a value on them, for the most valued things have no value in our eyes, they are so common. Air, without which a man could live but for a few moments, has no value in his eyes.

So all these things —all vegetable and animal beings —are built of one building material, protoplasm, which as Huxley says, is not only a substance but a structure, a piece of machinery, a mechanism kept at work by

sunlight and heat, capable of producing when acted on by principles of living organisms of plant, animal, and man.

Living organisms are a thousand times more varied and more marvelous results than all the human machinery was, or ever will be, invented by mankind. Now who invented these living machines we call plants, animals, and men? We did not make them, they were here before we came, and a Mind infinitely wise must have made them, for they could not make themselves.

What a marvel it is that from them come such an endless variety of organic productions, from prussic acid, a most deadly poison, to the thousand fruits, the many kinds of sugars, gums, and starches, the numberless kinds of oils, waxes, gums, the essential oils, as turpentines, resins, rubbers, gutta-percha, the nicotine of tobacco, morphine, strychnine, curarine, and other poisons, tea, coffee, cocoa, liquors, wines, —all these, and thousands of others, come from these four elements combined in wonderful ways by the life principles living in the organisms of the vegetable and animal kingdoms.

Men can hardly believe that all plants, animals, and human bodies are formed of these four simple elements combined, in that wonderful variety, or would show such diversity, such harmony and beauty united with small particles of the other elements mentioned, if strict science did not abundantly prove it.

But there is another marvelous thing—the basis of protoplasm is nitrogen, with its extreme immobility. It is inert in itself, and plants or animals cannot take it into their systems directly from the air of which it is one of the component parts.

Sulphur required for birds is in the egg, which has all the materials required to build the body of the young. When you eat an egg, this sulphur colors your silver spoon. Man, animals of cow, horse, families, etc., want salt. Wild beasts go miles and miles to get it. Cattle deprived of salt, eat it with fierce

avidity, for their systems crave it. But you cannot make a bird eat it, for this creature needs sulphur and lime. A man must have iron, and you would find enough of this metal in the body of a man to make a knife blade. But some animals will not take iron into their systems, for it would kill them. As we pass along, examining the materials of which living things are formed, we are astonished at the variety of their instincts. Every one of these animals knows what it wants and what to avoid. You cannot make a horse, cow, or vegetable-eating animal eat meat, and you cannot force a wolf, tiger, or lion to eat grass, for they know the foods which nourish them. They even know what will cure them when sick. The wounded dog will lick his wounds, for he knows the antiseptic properties of his saliva, and most wonderful, he knew this long before antiseptics were applied to wounds after Pasteur's discoveries of bacteria floating in the air, which cause suppuration.

While animals live mostly on vegetable or animal food, each according to its kind, man was made to eat both vegetable and animal foods, and he, alone, of all organisms can live for a long time on either vegetable or animal foods, especially on vegetables with the proteids, as nuts, seeds, peas, beans, which have nitrogen, some of which contain phosphorus, sulphur, etc. For these reasons, bread of wheaten flour, triticum vulgare, is the most nourishing food known, and a man could live indefinitely on bread mixed with sugar. Well is it called the "Staff of Life." Many proteids are found in vegetables, such as roots and grains, whose fats are mainly composed of starch and sugar. The proteids added to protoplasm enable the living principle to build up all vegetable and animal structures and are thus described by Professor Haliburton.

"Proteids are produced only in the living laboratry of animals and plants, proteid matter is the all-important material present in protoplasm. This molecule is the most complex that is known, it always contains

five, and often six and seven elements. The task of understanding its composition is very vast, and advance slow. But little by little the puzzle is being solved, and this final conquest of organic chemistry, when it does arrive, will furnish physiologists with new light on many dark places of the science of life."

Plants are in everlasting sleep, animal and man grow during sleep, man knows not how he grows, how these materials are placed in his body, knows not how each of the millions of cells composing his body flash forth light through the microscope more beautifully than the most precious gem, why the living being follows the plans of its species no matter what the food and care, that each living creature is made according to the plans and specifications the Great Architect of the universe drew up for each species.

We admire the genius of the architect, who plans a beautiful building. But look at the beauty of plants in form, figure, flour and fruit: see the curved line of beauty in cells, muscles, movements and outline of plant and beast; study the marvelous beauties of the human form divine. Will you say an Artist of surpassing wisdom and taste for beauty did not plan the creation of these living principles which built these bodies ?

The living principles are whole and complete in the organisms and whole and completely in each and every part, for they are spiritual. Part or extension belongs to minerals and not to spirits, which are where they exert their acts. The human soul is in every part of the body, the physician will look in vain for it in brain, or heart, or other organ, for it is a spirit beyond the ken of any sense.

Scientists make fatal mistakes. They treat living organisms as minerals. Medical men look for the soul as though they could see a spirit, the false theory of atoms and molecules misleads them. Soul or mind are not even hinted at in medical studies, and medicine has not made an important advance for a century, except the

discovery of diseases caused by bacteria under the hands of Pasteur and Liebig, who examined lower forms of life. Surgery, taking life into account has made wonderful discoveries. When Harvey looked on the human body as a living organism he discovered the blood circulation.

Oxygen and nitrogen compose air high above the farm, extending miles are tons and tons of nitrogen, the food of plants, and which enters into the structure of every animal organism. Yet the plant cannot sift this gas out of the air. Animals cannot use the crude gases or minerals, for they have no powers to get their food from the minerals round them. All animal organisms must live on plants, this is the law of nature, and for this reason the plants were created before the animals. In this the animal differs from the vegetable.

But the vegetable cannot separate nitrogen from the air—yet this nitrogen makes the farm so rich when spread among the soil. Without this gas the soil would be unproductive. How do the plants get the nitrogen? The Creator has provided. On the roots of clover, beans, peas and other plants are millions and millions of microscopic bacteria, which secrete the nitrogen from air and water, and furnish it as food to the growing crop. Discovered only in our day the farmer did not know this. But when he wanted to enrich a field "run out" he planted clover or other leguminous crop, and found the next season his field was enriched—the reason he did not know.

But plants cannot wait a whole season, they want the nitrogen at once or they die. The Creator fixed his laws so the plants can grow. The lightning in the air forms ammonia, composed of one volume of nitrogen and three volumes of hydrogen, which condenses into two volumes. It is a colorless, pungent gas, strongly alkaline, which under cold or pressure becomes a liquid. Ammonia and other oxides of nitrogen in the same way offer nitrogen to plants, and through them to animals and men. Although plants live and grow in contact

with the nitrogen of the air, they cannot absorb it directly into their organisms, and therefore they get it in this way.

The leaves, the lungs of plants, absorb the oxygen and carbon-dioxide in the air, and use these materials to build up their woody tissues. Through their roots they take in water having ammonia, with the oxides of nitrogen, and with these they build protoplasm of the whole vegetable and animal world. The lightning and electric discharges, in the thunder-cloud furnished these materials, which are carried down into the soil by rains. These combinations and changes in earth, sea and sky go on all the time. The lightning required for summer growths takes place in summer and rarely in winter, when the vegetable world sleeps.

A gentle heat is absolutely required for growth, for nothing can live in either extreme heat or cold. If the general temperature of the world changed, rose or fell 72° F., life would cease to exist on our planet. If the earth was a satellite of one of the great suns, if we were nearer or farther from our sun. life would be impossible. Our world would be burned up or frozen with eternal arctic frost. Now who regulated these things that life might exist? Who foresaw and made our sun with yellow light, and gave it not the red light? Why was it not placed as a satellite of one of the purple suns with their awful heat, or near the other suns with their small heat? Who placed our earth here, and not as a planet of the mighty Areturus, which would in a short time melt and drive into mineral vapors every particle of which the world was made?

Who placed our world just where it is, and not way out where now Jupiter, Saturn or Neptune or Uranus now revolve in everlasting winter? Why did not the earth come forth from the revolving globe of heated matter where now Venus is burned up with light and heat? We ask these questions to draw the reader's attention to the fact, that our world is just in the place where living organisms flourish. An intelligence was

here when our world was made. He guided nature at the birth of worlds, and stood by when this earth was forming as a place for the future residence of man.

A certain, continued and small amount of carbonic acid gas—that is, carbon—one of the metallic vapors, is always in the atmosphere, and from this the plants and animals get their carbon which we see in coal or wood. The leaves of plants absorb this coal in its metallic state from the air, and the chlorophyll, which gives them the green color, under the influence of sunlight decomposes this gas, uses the carbon to build up plant structure and gives out oxygen, without which animal life cannot exist. The animal breathes air, dissolves its oxygen, which it sends through the blood to every part of the body, and brings back the worn-out parts in the form of carbonic acid gas, which it breathes out through the lungs.

Let us suppose another change took place, for example, that both plant and animal breathed out only carbonic acid gas, which is coal, what would be the result in a few centuries? The atmosphere would become so filled with gas, that all animals would die. If, on the other hand, plants as well as animals exhaled oxygen, in a few centuries all the plants would die, animals would have nothing to live on, and life would cease from our world.

But the Providence who built the orbs and covered ours with air and life, made these two great orders, plant and animal, so one might live on the other. The plant purifies the air for the animal, and the latter for the former. Destroy one and the other would cease to live. Did this come by chance? Did fate or accident preside over the creation of these orders of living beings, so one would sustain the life of the other? Apply the rules of probability, and you will be lost in the figures. The ratio of one to that of the figures which would represent the other would cover the surface of our globe. An Intelligence presided over the

foundation of plant and animal life. There is no other conclusion.

Carbon, or coal, which formed such a large part once of living plants, which now lies in countless trillions of tons in the earth, and which we dig as coal, can be combined with oxygen by heat, as some metals burn or oxidize by uniting with oxygen. In a fire this oxygen of the air combines with the carbon in coal or wood, and the chemical union produces the heat and light of the fire.

Chlorophyll, "green leaf," with its green color has a highly complex structure, not well known at present, into which iron from the soil enters. It stands as it were between the air and the structure of the plant, sifting out the coal in the air, as carbonic acid gas. The green chlorophyl sends through the sap this coal to build up the plant structure. It is found mostly in the leaves.

These leaves, the marvelously constructed lungs of the plants, do what no other agency in nature can do, produce the materials of growth in breathing. If you strip a plant of its leaves, you deprive it of its lungs and it dies.

They decompose carbonic acid at ordinary temperature, what no man or other thing in nature can do, using special sunlight rays, ranging from the most rapid waves beyond the blue rays, down through the spectrum below the red rays, and down to the invisible rays as the X-rays, N-rays and other ether-waves we have not yet discovered. This growth of plants displays a harmony, a dependence, interwoven one with another which surprises us. If one of these rays were wanting, the plant would not grow. Who arranged this harmony? Nature is blind and could not. Suppose our sun were of the red kind, having little heat, or suppose it were a blue sun in place of being a yellow orb, plants could not live, they would either die with cold or burn up with heat. Beside this, yellow light alone sustains life in all its varied functions, and red or blue

rays would not cause the chemical changes and functions of plant life. Was it an accident that our sun shines with yellow light which alone can sustain plant life? Again we are forced to say a Mind presided over the formations of the sun and the creation of plants to live through the operation of his yellow light and gentle heat.

The wondrous work going on in plants is thus described. "We have seen how gre en leaves are supplied with gases, water, and dissolved salts, and how they can trap special ether-waves. The active energy of these waves is used to transmit the simple inorganic compounds into complex organic ones, which, in the process of respiration, are reduced to simpler substances again, and the potential energy transformed into kinetic. These metabolic changes take place in living cells full of intense activities. Currents course through the protoplasm and cell-sap in every direction, and between the cells which are also united by strands of protoplasm. The gases used are given off in respiration and assimilation, are floated in and out, and each protoplasm, burned or unburned, is the center of an area of disturbance. Pure protoplasm is influenced equally by all rays, that associated with chlorophyll is affected by certain red and violet rays in particular. These, especially the red ones, bring about the dissociation of the elements of the carbonic gas, the assimilation of the carbon and the excretion of the oxygen." Cham. Encyclop., Art. Veg. Physiology.

CHAPTER XVII.—THE INSTINCTS OF PLANTS.

Nature has few sudden gulfs or gaps. Like morning's aurora before the sun, kinds of creatures gradually seem to blend or overlap species above or below; lowest plants and animals look alike; highest beasts in mode of life and organs, resemble human beings; monkeys and apes look like men but have no reason. Two kingdoms the seen and unseen, dead matter and living beings, spirit realms seem to overlap, bend down, making matter live as reasoning men, mineral, plant, and animal; form three steps, which rise to man, binding visible worlds with unseen living spirits, at whose head is God.

We saw how matter has no sense or reason to direct its moves, that the Almighty's mathematics and physical laws rule matter, sun and orb, keeping the universe from running to chaos and anarchy. But unbending physical forces, mathematics, great heat or cold, an electric shock, etc., directed by figures, would kill life, which begins in plant, rises up to animal, ends with man, with his Godlike reason, liberty, free will, master of his acts.

Plants live lowest lives, beasts have more perfect lives, man, most perfect plant and beast have some of his soul powers buried in his body, angel lives free from matter, God lives His own eternal life. Man begins the order of thinking, reasoning beings, above him is the angel with his better reason, at the head is God, eternal Reason, with His Mind and Will, from which come His Son and Spirit.

Everything in nature has a purpose, an end towards which all its acts tend. The universe was made for man's use and benefit, man was made first here below, God to know, Him to love, to be with Him happy after this short life, not a tick in time since creation compared to eternity.

Plants, beasts, even men are directed by instincts, meaning "moved within"—the wisdom of God directing creatures to their ends. The end of God is his own eternal Being, the end of reasonable being is to be happy with Him, the end of plant and beast is to serve mankind. To this tend their instincts, written in the very nature of the vital powers. Having no reason themselves, guided by God's reason, they show astonishing wisdom, in nature they follow instinct, outside that they are most stupid, you must force them to act against their instincts. When they gain their objects, food, growth, the propagation of their species, they are satisfied; man is never fully happy here, no matter what he has; his reason rests only in union with his God.

Scientific people, learned only in special departments of knowledge, never rising to the philosophy of life, working along narrow lines, fill books, try to show plants and beasts adapting means to an end, reason; publish wild, foolish, crazy theories attracting for a time attention, because of their novelties. We cannot go over the whole field of instincts of plants, as books would not hold them.

Materials shaped in pipes are stronger than in any other arrangement; engineers use hollow columns to upbuild heavy buildings. This principle of mechanics is found all through nature. Cut a tree or stalk, look down through a microscope, at the end you will see the structure of little pipes, hollow columns side by side, their walls uniting. Through these hollow columns the sap circulates. Grasses, weeds, the stalks of forms of plant life are hollow, the hard parts of birds' quills and bones are also on the outside making columns, structures built according to this principle of mechanics. What Builder built these forms this way long before man discovered this is the strongest method to arrange materials?

Plant and animal take food, digest it, put it through a wonderful process of chemistry, and unite these materials in wondrous ways into their structures. Who is

this Chemist of surpassing wisdom? Where did He learn chemistry, this is a modern science?

Passing through multitudes of chemical changes the plants grow—some from the outside, others from within, under light, heat and change, till materials are formed and placed just where wanted in growth.

Plant life is slow, grows slower than animal and lives longer. On his own place the writer cut the sugar-maple trees of which the house is built where these lines are being written, he carefully counted the yearly rings, one tree had over 400 rings, other trees larger still stand, were left because too heavy to handle. Four times he counted these rings each the growth of a year, then sat down on the stump and thought—this tree lived when Columbus landed.

In California he saw trees more than 30 feet in diameter, members of the giant Sequoia, which perhaps were living while Solomon was building his famous temple roofed with the wrongly called "cedars," for they belong to the larch family, only a few trees of the original forest now remain covering a hill in the Lebanon mountains. In California are forests of another giant tree, the sequoia sempervirens, nearly as large. These specimens are the only remains of vast forests once covering the northern parts of the world before the ice-cap came down and buried them, we find their remains in coal. The ice could not pass the great Sierra Nevada Mountains, so the species survived only on the Pacific Coast. We could fill books with the wonders of plants, space permits but a few words on the way plants are propagated.

Lowest organisms propagate by budding, dividing—one individual separates into two or more individuals. As we rise we see new individuals germinate from two sexes in the same individual. Higher still we find individuals of two sexes must mate to bring forth another. This in highest perfection is in man and woman, "the womb man," with mating instincts most wonder-

fully directed by instinct. We might treat this subject in full, show the Creator's wisdom in the mating of creatures, but the subject is delicate, for man is injured in his origin, bears the instinct of shame in matters relating to the generation of his race as a mark of his fall from a higher state.

What is more beautiful than a flower, there takes place the generation of plants of the same species. Put a little pollen from a flower under the microscope, and you see minute grains, each according to the species, shaped, colored, mosaic-like wondrous forms, beautiful above the work of any artist. This falls on the stigma of the flower and impregnates in a surprising way. Chemistry, mechanics surpassing in wisdom, follow till a seed is made. Take the spermatozoon of higher animals; each species has its own proper germ, which will not unite with the female element of any other species. While the pollen of the plant rests motionless, that of the animal is filled with life, for it belongs to a higher order of creation. In a later chapter we will describe that of man. We cannot go over the whole domain of nature to describe the germination of all plants and animals for there are millions of species. We will look only, at a few that the reader may glance at some of the marvels of nature, and from these rise to the wondrous wisdom of the Creator. Let us look a little at the plants and then see the animals.

Grass and weed, flower and fruit, shrub and tree—each plant and living organism is a book filled with wonders, teaching truths, proclaiming science, singing silent songs of praise to Him who made each creature in his image. We are ignorant, our minds are darkened, our attention is taken up with thoughts of other things, and we do not stop to think of the wonders of life round us. We like to read books by skilled authors, but we know not how to read the books of God, the revelations of his glories written in the million books round us.

Go out in the forest, look at trees and bushes along

the roadside, see the weeds beside the fence, the green of field, hillside—the wisest man who ever lived was ignorant compared to these so humble and so silent.

At the first glance they seem irregular, without form or order. But get up on high where you can look down on these green forms of lowly life, and you will find every limb, stalk and leaf just where the sunlight will fall on them to best advantage. Crawl down under weeds or bushes by the way and examine them. See, the leaves grow out just in the right place and turn to get the proper light. See how plants which like light and heat grow high above, while weeds that grow in shadows are down under in the shade. Take your time, you will find a wondrous wisdom presides over the growth of every plant.

Limbs look as though they came out in most irregular ways. They are here and there, and turn everywhere. But look down on the growing plants from where the light strikes them, and you will see every branch has turned in the right direction so it will grow where the leaves will get best light and heat its growth wants. It seems as though some unseen Spirit had pulled them in the right direction. In early spring bend down one of these trees, shrub or weed and tie it there, and leave it thus. Soon limbs and leaves will bend to light. We seldom see a forest from high, in the air—mostly from the ground, and we do not know these things. Who is the silent Unseen who shapes these unreasoning living forces for the better growth of plants?

Some plants grow on warm hillside, others on the plain, some in marshy places, others on the mountain top, some in waters of lake and pond, others in salty seas, yet each has its own habitation and will die if you transplant it to other clime or place. Man cultivated some plants from the beginning, others are still wild. Some are useful, others medicinal, and our drug-stores are lined with their Latin names. Many weeds we execrate and would wipe off the face of earth because we

do not now know their use, yet they persist in forcing themselves on us till we learn their natures.

We sorrow the limits of our book will not allow us to go over the whole domain of Botany, "a plant," the knowledge of the vegetable kingdom. There among the plants the science of an infinite Power shines forth. We can only give a rapid glance at a few wonders of plant life.

Asked what plant is most valuable to mankind you would puzzle to reply. It is the little grass under your feet on which domestic animals live. It seems worthless because it is so common. It is so necessary for man the Creator endowed it with a surprising vital force. When animals eat off all the leaves of most plants they die, but the grass grows again. When forests, bushes or weeds are cleared away grass springs up because it is required for food for domestic animals which without it would starve.

Some plants shed their leaves in the fall but when spring heat rouses them from winter sleep, the sap comes up from the roots buried in moist soil, passing through soft tissues between the wood and bark, till it enters the leaves where, acted on by the air, it receives carbon of the atmosphere in a state of gas, at the same time giving out its oxygen. The sap passes down again between the bark and wood of the tree, and forces out the bark all round making the tree larger. Little by little as summer advances, the new layer becomes harder, till in the fall a new woody layer has been added all around the tree. Thus a new layer is added to the tree each summer and you see these layers in wood boards each year making a layer and the old dead bark lies in layers.

The tree not only grows larger in diameter but taller, for growth takes place through the whole organism. In the corn and palm tree, etc., the growth takes place from within all parts of the plant. But in our plants which shed their leaves in fall growth takes place between bark and wood.

Beautifully blends nature's works guided by Reason infinite in wisdom. Plants furnish food for animals, and these distribute seeds. After a walk through weeds in fall who has not found burs in his clothes? By this means animals distribute seeds of plants they do not eat, for there is a mutual service and a brotherhood of all creatures under the Fatherhood of God. Animals have instincts of cleanliness. After running perhaps miles, they lie down and with their teeth pull off these burs, and next season upwards spring new plants. Fine seeds stick to their hairs, they bathe their coats with the tongue or shake off the seeds. The burdock incloses sometimes 16 seeds, which are shaken out as the animal runs. The cockle burs must be pulled out, one at a time, they have a way of clinging to each other like children holding hands so bunches of them cling to the animal's fur, the animal using his teeth tears the burs apart scattering the seeds.

The hedgehog-grass or sand-bur has one or two seeds inclosed in small hard burs, bristling with spines, pointing in every direction, which cling to anything touching them. When ripe they attach themselves to man or animal, and are carried away till the burs break off, when the seeds fall. The beggar-lice and ticktrefoil growing in woods or brush, have burs with four seeds in each like the four quarters of a cut apple, their backs being covered with hooks, each breaks off separately in the case of the first, while the latter has strings of long pods all covered with microscopic hooks, which grasp the hair of animal or your clothes and the seeds fall out as they are carried along.

Grasses use different means of spreading their seeds. The cultivated grasses seldom have any methods of scattering their seeds, for they were created to be sowed by man. But the wild neglected grass, similar to wild rye, has awns in shape of a trident with the seed in the center, the stiff short spikes stick to any animal, and thus the seed is carried. When you walk through the

fields and weeds in fall, you find your clothes covered with its seeds. Examine them under the microscope and you will be astonished at the means taken to spread the species. The soft down of milkweeds, cat-tails, anemones, cottonwoods, willows, etc., will surprise you when examined. Each shows seed in nature design, a Mind which foresaw and used means to gain this end.

Nuts are sweet and nutritious that animals may eat or hide them, often the hiding-place is forgotten and the seeds grow to trees. Squirrels, crows and other animals plant seeds, seldom more than one in a hole, and these grow. The chipmunk seizes the chokecherry, runs off to a stone or log where he sits up and eats the rich pulp. If a hawk or enemy appears the squirrel drops the pineseed, cherry, walnut or other seeds filling his mouth and scampers to his hole, and the seeds grow to trees and bushes along the fences.

Plants are spread over distant regions because their seeds fly, while seeds of cultivated plants do not fly because they were made to be planted by man, who, using his reason, chooses places where he wishes them to grow. Fields left fallow raise weedy crops differing from season to season, till the grasses cattle want smother them. We ask where did these seeds come from? God provided plants with these instincts.

Walking the field after a rain we find different kinds of fungus—the toothsome mushroom, the agarus campestris, the whitish yellow growth on decaying trees—a thousand kinds of fungus, each in species differing. Squeeze "puff-ball" when dry and out comes a puff like smoke; put some under the microscope and you will find the puff is made of fine little seeds, which falling in the right place grow in almost a night into the fungus. Here is a low order of life not yet well understood. People suffer with eczema. Examine with the glass the pus and you will find it is caused by a minute fungus having stalk and head like a mushroom with seeds on top. The plant secretes an exceeding sour sap which

causes the itching, and only the most powerful poisons, like bichloride of mercury, will kill it. It livs in the outer skin, often penetrating into the inner skin, causing sores and intolerable itching.

Seeds of fungus families are so small they float in air. But larger seeds have one or more wings. The dandelion develops the round white head which on damp days folds into a round ball, while in dry weather the head expands. Examine carefully, and you will see the end covered with black seeds, each ending in a filmy little stalk. The wind breaks these seeds from the stalk and scatters them over the ground far from the parent plant. The same way thistle seeds are scattered far and wide on dry days, but the head closes up during rains, for then the seeds would not scatter so far. As each seed flies away in the wind, it may be stopped by stone or fence, and this is why they are found growing in so many places.

Closely guards the golden-rod its seeds during fall, for its pappus, or wings, are small and light compared to the seed. But when snow covers the ground and fierce winds come, the furry heads open, and the seeds are sent long distances. The pappus of the milkweed is so fine and silky, so large compared to the seed, a puff of air will send it high, it does not need a windy day to scatter its seeds, whence as soon as ripe it opens out and scatters its seeds.

The cat-tail has a small seed attached, not to its inner end, like these given above, but to its outer, and it is so united to the pappus, that it is hard to separate till it falls on water. The center of gravity makes the filaments spread out, as it floats the winds blow the seeds along the surface till they find a place to grow on distant shores.

The sycamore has large round balls in which the seeds remain all winter, for they die if they fall before. In spring winds the seed is thrown out, the pappus hung to it turns over, spreads out like a parachute, and it

sails along looking like a little umbrella. The Virginia anemone, being a low plant, has not the advantage of the height of the sycamore to spread its seeds, therefore fine filaments are attached to all parts of the seed, forming a fluffy cottony ball borne away in the wind, or it becomes attached to the fur of animals. The clematis seed has long hairy strings which catch on brush or to any passing animal.

It is a principle of mechanics that a whirling motion is a great aid in supporting objects flying through the air, and this principle is applied to rifle and cannon to rotate the balls. Thousands of seeds having one or more wings use this whirling motion. Sometimes the seeds hang in a cluster from one stem, and as the wing becomes dry, the end turns up so that when the seed falls it whirls, the twisted end strikes the air at a higher plane, thus bearing up the seed so it is carried to great distances. Maples, box elders, ashes, etc., have seeds hanging in clusters, each with a wing like that of a bird, but bent so when the seed falls it whirls, the motion keeping it from falling till it is carried far away from the parent tree. The stem is so strong that only a high wind breaks it. The wing of each seed is so balanced and shaped, its front edge as it turns strikes the air higher than the rest, producing an upward pull. Maples shed their seeds in the fall, but ash, elders, etc., keep their seeds till the storms of high wintery winds carry them over the snows.

Evergreens, as pines, spruces, etc., have seed cones, which close in damp weather, but open with snapping sounds in dry, cold winter, when the seeds are shot out, each with a filmy wing, which carries them long distances over the snow. The round seed of the hop is tucked in between the fruit scales covered with very bitter, minute capsules, which give beer its bitter taste, and the seeds are shed only when the weather is right. The bear-grass has more than 450 seeds packed in each of its pods, and as they are shed each goes whirling in

the wind. The compass plant has a like arrangement to carry its seeds. The ragweed has little brackets on top, which turn in dry weather to catch the air as they go far and wide. Some seeds have wings which carry them high in the air over the tops of mountains. With all his knowledge man could not improve on these methods of distributing seeds. Who is this wise Person who planned the planting of these seeds?

Some plants tumble over the ground shedding seeds, while others float on water. Some are taken up by strong winds and spread far and wide in fall and winter. If you shake a stalk of beard-tongue, milk vetches, bellflower, Indian mallow, catmint or other plants on a dry, cold winter day, you will see their seeds fall on the snow, which drifting drags them along. Thus the lock, golden-rod, wild grasses and other plants spread seeds during winter. The means by which they are spread, each according to its species, are astonishing.

The Tartar thistle of Russia, brought by emigrants about 1885, overran some of the Western States. Its many branches form a round ball with two capsules on the end of each stalk. In the fall the root breaks off in the wind, and the plant goes tumbling over and over many miles scattering its seeds. You will see these balls sometimes two feet in diameter lodged along the wire fences of prairie farms, sometimes they even fill railroad cuts. The panicum and rattlebox grasses distribute their seeds the same way.

Ground cherries have an inflated calyx surrounding the fruit, which forms a balloon to carry it away in the air, and when they fall on the ground they roll in the wind. Some cherries are covered with a sticky material by which they adhere to animals and are carried away. Seeds of thousands of species of plants have different sticky substances which adhere to animals so they will be planted far from the mother plant.

Many seeds are carried away by water, waves of lakes, and running streams; the water will not kill the germs,

while other seeds not intended to be born away by water die when soaked. And these seeds fall just when rivers and lakes rise in fall rains, and they germinate miles away from where they grew. The lands are always sliding down into the valleys during rains, thus these seeds are covered as though some mighty Farmer planted them all over the surface of our globe.

Noah first made a boat, and he was laughed at, for no one believed a vessel would float on water. But if mankind, then in its infancy, had examined the seeds of water plants, they would have found many made like little boats—all these will float, while seeds of plants growing far from water sink and die. Great bulrush seed is flat on one side, edges turned up, upper side concave, looking like a broad-keeled boat. Rising from one end are four to six little bristles sticking up forming a sail, and the little boat bearing the living germ of a new plant goes sailing off to another shore, where it rests among the weeds till it becomes waterlodged and sinks to grow into another bulrush. The water plantain has a delicate brown seed in the center of a corky cushion. It sails along looking like a flat-bottomed boat—the thick side catching the wind bears it along for days to other shores before it sinks to grow. Other seeds of water-plants are covered with sticky substances by which they adhere to floating objects and are carried away. These seeds are built in such a way that the center of gravity is down near the bottom of the tiny boats so they will not upset. Many water-plants have fine seeds which will not sink for days, they are blown to distant shores and left high and dry when the water goes down in the balmy spring, so they can germinate. Men often ask how islands, thousands of miles from land, became covered with vegetation, but if they will examine seeds they will find that a Power infinitely wise provided the means.

How oft we plucked water-lilies in Adirondack lakes, and have seen the deer come down to eat their beautiful

flowers! How did these plants get from one pond to another? Its seed pod is a large round boat, which carries 15 to 20 passengers—each with his separate berth. Carefully, while green, this boat holds its seeds with a firm rim round the shoulders of each. When ripe the stem breaks off, and away the boat floats in the wind, off down stream into lakes and ponds. The rim around each seed dries and expands, till one after the other the seeds drop out, and find lodgment in mucky soil of pond bottom. Other seeds fall only in coldest weather on the ice, to have the wind skid them along to farther shores miles away.

Canadian violet, jewel-weed, vervane, bear-tongue, catnip, Indian mallow, are found in dense colonies, yet not too dense for vigorous growth, and when touched or in the wind they throw their seeds a little way from the parent plants. C. S. Thomas counted over 40,000 seeds on a catnip, 15,000 on a bellflower. Professor Kerner of Vienna found 10,000 on a henbane, 730,000 on a Sophia mustard. He estimates that if all the seeds of a henbane germinated for five years, they would cover all lands, and that under the same conditions a mustard would cover 2,000 times as much land as earth surface. But seeds are eaten by man and beast, those eaten bear the largest crop, the number of animals to eat them is such that the balance of nature is adjusted so they do not grow and smother other plants useful to us. Who keeps nature in this balance?

Some plants have seeds in peculiar pods and capsules, ripe they burst and shoot out the seeds. Put a ripe phlox in a dish in a room and soon you will find seeds and capsules scattered all over the floor, each sent out like a little bullet with an explosion. If you touch the pods of the jewel-weed it will shoot its seeds quite a distance. Some violets shoot their seeds as a boy snaps cherry stones from between his fingers. The wonder is the stalks rise up to their fullest height before they shoot out their seeds, to project them as far as they can one after the other.

The crane's-bill has five seeds at the base of a cone, each inclosed in a capsule, and when the seeds ripen the skin of the capsules dries on the outside first, contracts and finally shoots out the seeds four or five feet. Who told the sunflower to turn its head towards the light? It holds up its head to keep its seeds in cells resembling honeycomb, each inclosed on three sides with a chaffy scale twice its length. All point upward till the strong winds of fall come to bend down the stalk when the seeds are shot out like rifle bullets, when gusts and drifting snows carry them long distances. The catmint has dense flowers in clustered spikes, each calyx has four tiny seeds set at right angles, and the lower side is curved to give the seeds an upward turn when thrown out to be carried in the wind, and the wonder is that most pods close in damp weather, to hold the seeds, and open in dry weather to shed them. The walls of capsules and the seeds are smoothed and polished so the seeds can fall while the skin on the outside is rough. What order, design and regularity are seen in it all, what method and mechanics are used to accomplish the growth of other plants!

Some flowers bend down while most point upward as though unwilling to shed their seeds. Long or short beards bend over but keep the seeds till the right time, when these hair-like processes open, some in wind, others in rain or sunshine, just in the proper time for the seeds to sprout. The bellflower has a capsule with three divisions, each filled with seeds; each has a tiny hole just large enough to let a seed out one at a time—there may be 75 in each division—one of these plants had 19,000 seeds. One seed comes out from each hole as the stalk is shaken in the wind. Thus the plant waits till winds come in strong gusts from every side, when it plants its seeds in all directions. Who shall say there is not a mind directing nature or that these things take place by chance?

Pumpkin, squash, melon, have seeds covered with a

sticky paste which sticks to animals so the seeds are carried away; while most animals kill seeds when eating them, birds do not. Birds eat berries and carry their seeds long distances. The writer owns a watering-place with two large mountain ash before the house, where the birds come in the fall to eat the red berries. He began to think there was design in this, and found over 300 ash trees scattered over his place, mostly in the primeval woods along his half-mile of lake shore, some of these mountain ash being quite large. Robins, bluejays, thrushes, bluebirds, yellow birds—in fact nearly all our birds eat cherries, raspberries, blackberries, grapes, blueberries, strawberries, all small fruit, and spread the seeds all over the country. Without them the woods and waste places would not be covered with wild fruits for man's use.

Ducks, geese and water-birds eat seeds of water-plants and in their migrations scatter them from South America to regions round north pole, where they grow but do not produce seeds, because of the short season. Without these birds and their instinct of emigrating each season, these cold regions would be barren. Why do ducks, geese, etc., dabble in water? Their bills are like a strainer and they sift out the seeds and larva for food. The seeds live and may be planted 1,000 miles away.

Dip a paper into a shallow pool and put it under the microscope, you will find the food of these birds almost darkening the paper. Without knowing, these birds spread the plants and animals on which they feed far and wide, not only by their droppings, but they carry on their feathers, which they always preen when they light in waters. Who gave plants and animals these remarkable instincts so that these species are spread far and wide? We must admit that it would have been impossible for man to spread the wild vegetation through woods, fields, waters, plains—almost from pole to pole, if the Creator had not given these astounding instincts.

CHAPTER XVIII.—THE INSTINCTS OF ANIMALS.

We glory in the progress of our age, within the last century improvements uplifting humanity have made giant strides. Trade is wiping out the boundaries of nations, the world is being wound by electric wires, science is advancing, natural forces are being harnessed, so time will come when man, with his reason, will direct natural forces and beast doing all laboring work. All this takes place because of the blessing the Creator gave humanity. "Fill the earth and subdue it" Gen. i. 28.

But what are our machines compared to the matchless machineries of instinct-built animal organisms. Under the microscope you will see shells, muscles, bones, ropes, pulleys, pipes, flowing fluids, living, moving using heat in movement a thousand times more complicated, perfect and wonderful than our remarkable inventions. No principle to-day used in human machinery that is not found in nature. An Inventor, a Workman, an Engineer, a Chemist, a Pipe-Fitter, an Hydraulic Engineer, a Scientist, with Wisdom infinite, was working in nature before man learned these things. Who is He? In our pagan darkness we call Him Nature, as though it could reason. Why don't we give God the glory belonging to Him, except there is a dark wound in our reason?

Beasts know not how or why they were made, their end was marked out for them by the Creator. They reason not, have no minds, but in the most astounding way they adapt means to gain their ends, the perfection of the individual, the bringing forth of others like themselves. They are guided by instinct—their Creator's wisdom. All we say regarding instinct of plant and animal supplies to man, highest plant and animal. For before reason dawns and instincts guide the child.

Face of man or beast is made of little muscles, attached to little holes in the skull, or hitched to the bones from which they spring, overlapping each other, otherwise the face would be out of shape, the wisest engineers could not make a like structure. The lady, glories in her beautiful face, form and figure, seldom stops to think growth instinct of her soul made her from matter once dead, and that it will return again to earth.

The block and pulley was a great invention used on ships from prehistoric time, but man and nobler animals carry four in each eye, and many others in their bodies. The photograph was looked on as a wonderful thing, but the eye of man and animal is an instrument which photographs in colors, images forming and reforming with the rapidity of lightning, as we look at different objects. The telescope and microscope were remarkable when first invented, but every eye is both instruments combined. With what wonder we first looked at a fly's eye with over 500 lenses in each, ranged like cells of honeycomb—each species of insect has eyes formed along these lines adapted to their modes of life.

The steam engine and locomotive were remarkable inventions, but each living organism is both combined, for they change heat into muscular movement. We heat our houses with hot water or steam, but millions of pipes bring warm red blood rivers loaded with oxygen from the lungs to all parts of the body, where uniting with carbon, a slow fire burns in us all the time, keeping us warm.

On the steam engine a safety valve lets off steam when the pressure becomes dangerous, but each man has over 2,500,000 of these valves in his skin called sweat glands; when we get too hot they open, pour out perspiration, which, drying, cools us so the heat dōes not rise to the dangerous point, without them we would not live a day. Each beast has them arranged according to his mode of life. When they do not work people are killed with heat.

The cup and ball joint was a great invention, but

there are many joints in your body much more perfect. You have a ball and socket joint uniting your limbs to your body, with them you move your arms and legs in any direction—air-tight sockets kept in place by air pressure. If not made that way, you would soon tire keeping them in place, and all joints in bodies of man and animal are held that way. We must oil our machinery at stated times, but these joints are kept oiled all the time, so they do not rub and get injured, and if the oil is let out it forms again in a few hours.

The heart is the most perfect pump in the world, being 1,000 times better than any man ever made. But it is more, for it is a double pump, oiled all the time within and without where it moves over the surface of the other organs. Each day it exercises a force which would lift 120 tons a foot high, raising a weight equal to itself 20,000 feet an hour while a strong man can raise himself only 1,000 feet, getting very tired at the same time. Each beat the heart could force the blood through a rigid pipe 200 feet.

Belonging to the plant powers of man, the heart, independent of our control, beats faster in disease and injuries, and is kept in action by nerves from the brain, for if we forgot it we would die in a few moments. Did not the Creator sweetly arrange these things? Most perfect force-pump, it shoots the blood formed of nourishing materials through arteries carrying life-giving oxygen from the lungs, passing thousands of valves, arteries divide into smaller and smaller pipes, getting finer than hair, bathing at last millions of cells to which it gives life. Then it comes back through the minute veins, these getting larger and larger, till at last the blood passes through the lungs again, yields its carbonic acid, receives oxygen and again sent over the same route. This takes place in every organism, each species having a different kind of heart from lowest beast to man.

Organs must rest, periods being longer or shorter, the heart taking the shortest, to the brain and nervous system

which rest during sleep. Heart beats a little more than 60 times a minute in normal health, faster in infants, sick and old people, each beat being half work and half rest. The muscles rest when we sit or recline; the brain works all the time when we are awake.

When we get excited, or work too hard, the heart pumps blood rapidly to the brain and if it could not be stopped by some mechanical device it would burst the blood-vessels and thousands would die of brain fevers and apoplexy. Physicians thought for ages that Adam's apple was a useless freak of nature, but it serves as a check or storage cistern which controls the blood when flowing too fast, and when it does not come up in sufficient quantities, the apple supplies the right amount. The flow of gas, water, steam and fluids in pipes is controlled by valves. But the valves in human body, animals and plants are far more perfect than man ever made Millions of different valves are found in living beings, each perfected for the work it has to do.

In swallowing, food or liquid must pass over the passage leading down into the lungs, for the windpipe is on the outside so it will never while eating or drinking close, and the passage leading to the stomach is within because it is not so important as to be kept always open. For we can go without food for quite a while, but not without air. The air-pipe leading to the lungs is instinctively closed by a most wonderful valve called the epiglottis, " over the tongue." It is in the back of the mouth just where the air and food passages cross. When you swallow the epiglotis valve automatically closes stopping the food or fluid from going down into the lungs, for if things filled the air-passage they would prevent the air entering and we would die in a few moments. We open and close this valve without thinking, we could not do either if we tried, so well is the machine made that it works by instinct without notice from the mind.

A level is a very important instrument for builders,

But there are six levels in the head, forming part of each ear. They are filled with fluids which flow back and forth, instinctively informing us of the position of the body. When we lean over or lie down these levels tell us. After reclining a long time, getting up we feel dizzy till the fluids readjust themselves.

The spine of man and animal is the most wonderfully constructed piece of machinery ever built. For though made of hard bones it bends in different directions without breaking, and protects the spinal marrow from injury. Materials could not be placed in any other way to so well accomplish the object.

When Brunel started to build a tunnel under the Thames, London, he studied the plans of the teredo, a worm which bores into wood under water. The animal, as he eats his way through the wood, lines his tunnel with a limy secretion which becomes hard. Following the example of this humble shellfish they built a steel shield they force ahead, the engineers then line the tubes with steel rings as they go along, then strengthen them with concrete. Insects use saws, lances, chisels, pincers—all our tools are but duplicates of those we find in nature.

The wasp, guided by instinct, makes paper for its nest of wood fibers, gizzards of certain insects and birds, and our teeth recall the mill for grinding grain; the physalia swims on the sea with a bladder filled with air, the velilla hoists a sail and is borne away in the wind, wasps, hornets and spiders of California build nests with a skill which puts us to shame; the cockle, grasshopper, flea and other insects jump marvelous distances for their size; the solen with its feet burrows into the sand in a remarkable manner; the mussel spins thin horny threads by which it anchors to the rocks, and the cuttlefish and others of its class has hundreds of suckers with which it seizes its prey.

So all living creatures led by instinct use the most wonderful art and mechanics and engineering devices compared to our machinery and inventions. The great

marvel is those machines live. The more we study them the more we are astonished. These machines are perfect. Under the microscope the point of a needle looks like a crowbar, while we cannot see where the sting of the bee or wasp ends it is so sharp. The finest works of a watch show great scratches, while the structure of an insect is so smooth and polished we find no irregularity, as in the works of man.

Little birds on the nest have no instinct of fear, for if they jumped out they would be devoured or die; when the time comes they know how to fly, and see how their feathers form to catch the air, while for ages we have been trying to find the secret of their flight. All animals know by instinct how to swim, but we must learn, they know good and bad food; you cannot make them eat what would injure them, when hungry or thirsty they eat or drink; you cannot force horse or cow to eat meat, or dog and cat hay, when sick they know the remedies nature has provided; they know beforehand storms are coming; in fall they retire for winter sleep; they labor not; neither do they spin; yet they are clothed according to the climate.

When Adam named the animals, he called the goose kazah, "stupid." What a fool that bird is, what foolish things a goose will do, for when tamed he is not in a natural state. Take the bird in his wild state—the anser canadensis, what wisdom he shows in his flight from frozen north to southern shores. Who has not seen a flock of geese in the form of a V with the leader at the point flying high overhead winging their way north or south. Most birds leave us in the fall for warmer climes and come back in spring as wealthy people go to rusticate. Who told the birds to do this? But the crows remain with us wintering in deep forests. Where do they get their food? The writer had a tame crow which used to hide all kinds of food for winter use and he showed the most astonishing wisdom. Crows hide seeds for winter use, many seeds they bury grow to trees. The

writer caught a woodchuck a few days after birth, he became very tame. In looks, actions and instincts he was like a bear, to which he is closely related. He did the most laughable things—he and the crow were almost equal to a circus. After writing all day, I would go and play with them, for they were as tame as dogs. They showed the most wonderful instincts. Animals treated harshly always fear man and cannot be well studied. These little animals were never hurt or frightened, but treated as children. The woodchuck had an enormous taste for sweets, the crow would steal and hide bright objects. We had to feed the crow by hand till he was six weeks old, putting the food into its mouth, but the chuck learned to eat within a few days. At the same time we had sixteen different tamed American birds, with a rabbit, and called them our "menagerie." They were very interesting.

In lowest organisms one individual gives rise alone to a new individual of the same species, in higher plants and animals the two sexes are on the same individual, generally in the flower, in nobler animals and in mankind the sexes divide, each individual being either male or female. They are about equally divided through nature, but more girls are born than boys to make up the loss caused by motherhood. Who balanced nature this way but Providence presiding over nature? Suppose all of one sex came into the world for some years the species would die out.

With few exceptions the male is large, hardy, strong, the female small, weak, tender. He was made to be the father, she the mother. In nature the male is the most beautiful, the female is clothed in dimmer glories—this is seen especially among birds. In mankind the woman is more beautiful than the man, for she cannot well seek him, he gets her, and after marriage she follows him during life.

Nothing is more remarkable or more beautiful than the relations between man and wife. Instinct deep in

plant life functions of mankind, swaying even mind and free will, continue the species of all that live, for life must by its nature continue, life from lowest plants up through animal to man.

That blessing, "Increase and multiply and fill the earth," pronounced on our race, lasted to our day; among even lowest tribes, most degraded human beings feel the benedictions, for they marry. Man being highest plant and animal is the highest developed in all his powers of all that live on earth.

The gentle, little, timid maiden sees a man she never met before, falls in love with him, and he with her, neither knowing the divine benediction; they separate from home, friends, and all they know. Interfere with that instinct and you may dethrone reason, love is first in the mind, not in passion which ceases when they are old,while love in mind remains, or should till they die, thus the Creator ordained because children want their parents aid through life. They marry and bring to the church a little image of themselves.

He is the husband, "a farmer." Adam was the first farmer, she the wife, "woman," from the Sanscrit mana, "to think," and womb. Here are two men made with different instincts, the father and the mother. He never tires of her, as he would with another man; she interests him all his life, as no man would; he is hardy to deal with the outside world, she is kind and gentle to preside over home and children; he is her hero, she his glory. Why are these two men so different? What wonderful instincts have been working directing these two men? To the clean of heart all is clean, mock not now at nature's wonders.

In body man belongs to the order of animals we call the mammalia, which bring forth their young alive, and nourish them with mother's milk, what we say regarding animals relates also to man. Animals are born males or females. What causes such a change, when they live the same life before and after birth? Here

we strike down deep into the foundations of life. Instinct, or impulse of the Deity regulates life's origin; the sexes are born about even, and nothing man can do will change sex.

Soon after life of higher animals begins you find four bodies in the small of the back within, the two upper become the kidneys to sift out urea which would poison the system. The two lower may remain there to become the ovaries, "egg-producers," for every being with a backbone comes from an egg. Long before birth the ovaries manufacture fluids of a peculiar nature taken up into the circulation, as the young grows they pass into the blood, spread through the structure and build a female body. Later they produce the eggs.

But before birth they may come down into a special sack, the passage closes and they become different structures which manufacture other and stronger products, passing into the circulation and under their influence a male grows. During life these secretions being absorbed into the system continue making the male larger and stronger, till when full vigor arrives they manufacture the male element of generation. Dr. Brown-Sequard of Paris used the product of a ram, found it most stimulating when injected into the blood, but because of infection it was abandoned.

Whence that instinct that man and wife are nearer to each other than parents, children or nearest and dearest friend, how will science explain it? With a heavenly sleep to smother pain before sin came in, God took from the side of sleeping man a rib, bone and flesh of our first father, to show man and wife are one in bone and flesh, a rib against which his heart beats, to show wife is nearest in husband's affections, not from his foot to mean she was to be trampled on, not from his head to mean she was head of man, but from a bone near the middle of his body to typefy she was to be his equal, God made the first woman to be the mother

of us all, a prophecy of Him whose side was opened when His Bride, Mother Church, was made.

Inspired with vision of humanity streaming down all ages, Adam wakening said: "This is now bone of my bone, and flesh of my flesh, she shall be called Woman, because she was taken out of man. Therefore man shall leave father and mother and shall cleave to his wife, and they shall be two in one flesh." Gen. ii. 23–24. Alas! sin, crime, infidelity, passion, broke the beautiful bonds. Divorce blackened human history, and to-day threatens to disrupt society.

Animals, too, received that blessing, "Increase and multiply" Gen. i. 22. To continue their species they are in a natural state, they find no shame, no more than the flower in which are the two plant sexes. Generation of living organisms here image generation eternal in God, for He lives and His life by its very nature brings forth.

Why are we shamed and pained in that God ordained? Why woman feels it deeper except we are fallen beings, injured in our origin and bear the wound in powers origin of others? After reason dawns we must be clothed, because an instinct tells us we are not as God made the first two members of our race. Who will deny there was not a deep wound made in our nature by sin, as the story comes down, "And the Lord God," Jehovah Elohim, says the Hebrew text, literally meaning He Who Exists, The Mighty Ones, "made for Adam and his wife garments of skins of animals, and clothed them." Gen. iii. 21. Some say of skins of beasts He showed them how to sacrifice for their sin, images of Him who was to come and redeem our race.

Animals, especially birds, show images of marriage, because the young want their care. When the young can get along without the parents, after mating the latter separate, in higher beasts the mother has milk the young suck, when the pressure of the air forces out the milk; in some species the father takes care of the

young. While the little ones depend on parents they love them, when grown up they send them away—a thousand suprising things are found in nature guided by instinct, Wisdom and Foresight foreordained that their species might continue.

How beasts foretell the weather, provide food, make nests, dig holes, know food they want, avoid danger, provide for young they never see—a thousand things might be given showing wonders of animal instincts.

CHAPTER XIX.—LOOKING THROUGH A WINDOW DOWN IN OCEAN DEEPS.

Out o'er ocean wide and wild, like a little child, we like to gaze, then up to God our hearts we raise, joining nature ever singing silent praise. O'er storm-beat shore the billows roar, washing sand and strand. Moveless never, restless ever, from on high, bends the sky, where dimming light ends our sight. Thus we see the sea far and nigh, looking like an earthly sky.

Waves restless roll, storm-tossed from pole to pole. Deeps human foot has never trod, hide many a wondrous work of God—forms of life we never saw, live according to his law, so strange appear from beings living here. Though hidden from our sight, when they are brought to light, they show the wonders of the Infinite. When from hidden nook we them catch with net and hook, or with the trawl into light we haul, these creatures of the sea, are always found to be, in beauty, form and kind, works of the Almighty Mind. To us they show, working in waters down below:

A Mechanic, Matchless in Civil Engineering,
An Artist, Astounding in Beauty-Forming,
A Painter, Wondrous in Color-Blending,
A Sculptor, Surpassing in Wisdom-Working.

The beauty of our body, the human form divine, plant, bird and beast, even lowest and the least, if we only look we will find a book, thine and mine, written by a Hand divine, in each His wonders shine, teaching truths of Him all the time. But men of every kind, have a darkened mind, and weakened is our will, as though a poisoned rill, runs through our very being, blinding us from seeing, for at the fall we sinned all.

During all our days we are worldly all our ways, in thought and act seeking self, and spend our lives looking after pelf. Now let us see some secrets of the sea.

WHAT IS THE OCEAN?

Inscrutable and doomful deeps,
Where Solitude, calm Spirit, sleeps,
Beyond the fartherest seeking sunborn rays.

There Silence everlastingly abides,
While rithmly the restless tides
Check off th' unreckoned lightless ocean days.

No temple of the olden time,
Was ever like to this sublime,
Yet from the ken of men so much unlinked.

Here broods God's Spirit awesomely,
In his secret Sanctuary of the sea,
Mid living forms so much from man distinct.

Down where deepest darkness keeps,
Where silent water ever sweeps,
God made millions of creatures there to live.

Though these forms we seldom see,
He made them there that they might be
For our use, sea-food to us they give.

So it ever was since life began,
yThe were there when He made man,
So when our earth grows old and cold 'twill be.

Then man will rest in God his goal,
This is the end of every human soul,
Come see the long-locked secrets of the sea.

The writer made and placed in his dining-room an aquarium, holding about a barrel, the four sides of glass, fed from a spring of running water, wherein he put different kinds of fish to study. Fish are covered with a thick transparent mucus so the waters never touch them. If this be rubbed off it grows again as it prevents disease germs attacking the fish. Some fish are great eaters and grow rapidly, they eat at irregular times, sometimes going for days without food—this explains

why some are larger and why some days they "bite" well. A small mouth bass "bossed" every fish, going round and round with head and tail up, his whole time being spent in keeping all others in order and subjection; he would allow no other fish near him—this explains why you will never catch another fish where bass and trout abound.

The State Hatchery of Caledonia, N. Y., sent three specimens each of brook, rainbow and European trout. Before they got used to their new quarters, they tried to go upstream into the pipe whence the water flowed, and one of the brook trout shot out of the tank and landed eight feet away on the writing-desk, showing that they can go up any moderate fall. But how fish ever got up Niagara or very high falls of streams is a mystery, we must conclude they were created in such places.

The trout is the noblest of the fish tribe. But the brook trout, the salmo fontinalis, "the salmon of the spring," is the king of fishes, peerless, nervous, a thing of grace and beauty, lustiness and power, tenacious in battle, game and cunning, formed in lines of perfect symmetry, bejeweled, he flashes forth as though incrusted with most precious gems.

Fish are the most beautiful objects in nature, but we seldom see their surpassing splendors, because we look down on their backs which are generally dull in colors.

At night when shone the light, we could see their sides and bellies with silver sheen, with glimmering gold, with burnished gems, forms of beauty unsurpassed, as round and round they swam. They did not seem to sleep at night, but took little naps at different times during day or night.

The bass, bullhead, perch and other fish lived during the warm weather, but the direct sunshine killed the trout—the brook trout being unable to live in water over 44 degrees. This is why they are found only in cool brooks under shady trees. The trout killed every

other fish, not for food but in wanton savagery, and this is why you will find no other fish in a trout stream. Many things the writer learned from his studies of fish-life in this aquarium.

While the Atlantic seems like a desert regarding fish, the Pacific is filled with life. Here from our greater ocean, man yet will get most of his sea food. Here the Creator supplied an inexhaustible fund of food for man. Let us see a little of the living creatures of the Pacific. But language can convey but vague ideas of the wonders.

From 20 to 60 miles off the California coast a number of islands rise from the vast deeps almost like pillars, with no shoal waters round them. The warm, clear waters of the Japan current sweeping from the Indian Ocean strikes the continent, and tending south bathes the shores of these islands, making the climate of Southern California most balmy and even of all places on earth.

Taking the train at Los Angeles for San Pedro, the writer took the steamer for Santa Catalina Island, 20 miles out, and landed at Avelon, a famous resort, where people come from all parts to catch a great game fish, the tuna, the giant of the mackerel family. A number of people followed the writer along the sandy beach to the west, till we found the man with the glass-bottomed boat.

We cannot well see the bottom of bodies of water, because the reflected light from the surface is broken by the waves. But they overcome these difficulties by building a box-like compartment in the center of the boat, closing the bottom by a plate glass about 2 feet wide and 6 long. The boat was about 30 feet, and wide enough to allow us to sit at each side and look down through the glass.

As we pushed out, the sandy bottom appeared not differing from the beach. But when we got out into water about 6 feet deep, the line of seaweeds began,

and the growths became more diversified and larger as we advanced. It was a revelation. No plants growing in air look like these we see below sea level. The ocean floor is clothed with forests of giant seaweeds, forever waving back and forth with every ground swell. In deep water vines more than 100 feet long, not more than an inch in diameter, rise from the bottom with leaves about a foot wide and many feet long, the crimpled leaves assuming graceful shapes, bend over in the clear turquoise waters or crystal blue, similar to what we saw along the shores of Greece.

Trees have hard and stiff trunks, which hold up the limbs and foliage. But the stems of these plants were soft and yielding, easily bent as a rope. The leaves have capsules from about an inch in diameter, down to those of minute size. These capsules are filled with air they secrete from the water. These air-filled bladders hold them up. Who made these plants and covered them with hollow vessels filled with air so they float this way, as they are too close to be sustained like forests by large trunks as trees? Here is design. For He who made water plants knew that air is lighter than water.

Plants growing in air are nearly all green, for they secrete the green-colored chlorophyl. But the plants covering this ocean bottom were mostly yellow mauve, and the tints ranged down through these colors to dark brown. There was so sudden change from one color to another in the plants. The combinations of colors were perfect. It looked as though an Artist, with a taste for colors infinitely perfect, had combined these shades with boundless knowledge of harmony. We could see them forming a wonderful landscape, ever changing, growing down there from 20 to 60 feet below us in the clear crystal waters of the Pacific.

A new world was opened, expressions of surprise and joy were heard on every side as new wonders, surprising strange forms appeared below. Through the glass the view of the still waters below the boat was perfect.

A curtain of nature seemed lifted, letting us look down into a strange stage of nature, hidden mysteries of ocean life man seldom sees.

The great leaves, gray, green golden, of many blendings of yellow, carried by the fitful currents, wave back and forth, as they rise and fall, held up by capsules of air, growing on all parts of the plants. Trunks are not large like those of trees but small, the largest being about an inch in diameter, the foliage being upheld by the air capsules. Here is a kelpian forest covering the whole surface of the sea bottom, a wonderful ocean panamora, with long, round stems of a pale green and yellow colors waving back and forth, like light serpents never still.

We passed near the rocky cape jutting out to the west, on which rested a great crane preening his feathers. He seemed to have no fear of us, but with gentle curiosity he looked at us passing so near. We are more interested in the ocean bottom and give the bird but a glance. As we look down again a school of smelts dart by pursued by giant bass; as the water deepens, flocks of surf fish, gleaming like burnished silver, appear, then a cormorant dashing after them; and there is a sea lion browsing on the bottom. Suddenly the light grows dimmer, we are over the deep water, gliding over a dense kelpian forest, looking like "hanging gardens."

Great leaves rise to near the surface, droop over, making dark retreats, parterres—shady arbors suspended near the surface. The leaves are about a foot wide and many feet long, with crimpled edges, each covered with lacelike network of great delicacy and beauty. Fragile plumes wave back and forth, below and above, while as far down as we can see the dense forest swings to and fro, the greatest movements being near the surface, where the waters partake in the wave motions. Look at that silver tracery, white and gleaming like frosted metal, the deposit of some animal, covered with numerous minute sertuliarins, or water worms; see those others

of lavender hues. Oh, what combinations of greens, from the darkest to the lightest, how they blend with the yellow in all shades from darkest olive to lightest, frosted gleaming metal looking like burnished gold! Polish all the metals, mix bushels of jewels, blend them, combine them with all the industry and art of man, and they will not equal the shades, the colors, the beauties we see.

Fishes of all sizes dart in and out these leafy bowers, each clothed in the color of its species. But their colors are still brighter and more gleaming than those of the plants in the shades of which they live. Through a loop of kelp is seen the blue of the deep water; poised in it is an angel fish of vivid orange. Between the waving leaves are fish of all sizes from an inch long to a foot. Some are blue, deeper than the sky, brighter and more brilliant than any ribbon of silk the writer ever saw; many are brilliant crimson, some recall the flashing fire of burning wood. They are of all the colors of the rainbow, blending from the darker shades on the back to the brighter colors of the belly, as they dart in and out, or in play glide on their sides on the top of a leaf.

Now a school of these fish swim out into view, turning their gorgeous shapes upward to eye the strange faces looking down on them through the window in the boat bottom. With them are small fishes of brilliant blue, iridescent; others red and white, recalling the luster of gold and silver, or the gleam of precious gems and polished stones. The man of the boat tells us these are young angel fish, so called because of their wondrous beauties, the others, he says, are electric fishes, as they grow the blue merges into yellow, and the adult blossoms out into its perfect coat of gold, silver and orange.

On the great long leaves are red and olive crabs, singular in form and square in shape, while in the crevices of the moss-covered rocks are gigantic spider crabs, mimicking the rocks in shape and hue. Great pompons of weeds now appear of a tint born of the deep

sea, gracefully waving as the slight swells of the Pacific come in, perhaps from a storm on Afric's clime or Asia's shores; as the swell turns aside an arbor, it shows a very giant of the star-fish garbed in red, with white spikes hiding brilliant among the olive greens. In the rock crevices are smaller star fish, some vivid red, others darker red, with arms like snakes.

Among the weeds with long serrated spines wave the antennæ of the California crawfish, and there is the spiny lobster; its red-yellow and bronze-brown tints so harmonize with the color of the weeds it is hard to see it. Round swim great shrimps with numerous feet-like paddles propelling themselves along—some being nearly five inches long. Creatures of strange shapes, nameless to the scientist, are now found—no words can describe them, no language can convey an idea of their beauty, they must be seen to realize how God has filled even our greatest ocean with forms of life and beauty.

Now the sea bottom changes to finer moss, or weeds of deep velvet green, with here and there iridescent tints of yellow gold and burnished brass and polished bronze, in it is lying the sluglike sea cucumber of brick-red shades. There to the right below is a deep glen from which lacelike weeds rise and poise forming a safe retreat and shady canopy for the long-spined echini or sea urchin, and sea porcupines with spines all over their bodies. The smaller ones have splashes of white which disappear as they grow older. They cover every nook and corner of this ocean forest, and when an enemy comes they dart into this safe retreat.

Along this rocky shore, round this island rising like a great needle from vast depths, the whole bottom is a color scene and scheme of marvelous beauty. Green mingled with yellow is the predominant tone, but they are in countless shades—all blending one into another, from the lightest to the dark shading into reddish yellowish browns. A bright, short waving weed now moves aside to show other and more attractive colors: and dif-

ferent shaded weeds in purple and brown; look at those rocks of lavender incrusted with flaming red sponges, dotted with pink barnacles, from which rise the delicate mauve traceries of their breathing organs, through which dart in and out the brighter colored fish in all the beauties of their rainbow tints. This sea-tapestry of ocean depths is never at rest, ever changing in shades and colors, lights and tints, showing some new wonder every moment. Man paints pictures of nature's scenes, but they are dead, lifeless, motionless. But here are the works of God, eternal Artist, who colors creatures magnificently blazing in tints and gives them life and movement.

Now our window drifts over strange holothaurians like monster slugs, lying on painted rocks, in which live glasslike fish, mid hordes of mimic flowers, the serpulæ, with crowns of red, white and blue, tipped with burnished gold. A slight jar on the boat and they are gone from sight, for in a twinkling they folded up, to slowly unfold again their flowerly beauties when we kept still. Nearby are tubelike worms making tunnels lined with lime deposited round their galleries. From these humble worms men learned to line their tunnels under water with iron and concrete. There, out from beneath a rock, waves the tentacles of a devil-fish, the octopus with cuplike suckers all over his eight arms, with which he seizes his prey, and which would burn your skin like fire.

Where the sunlight beams down through crystal waters blue, myriads of fairylike forms, under bowers like hanging gardens poise, drift, swim, true gems of ocean. They are red as ruby, blue as sapphire, green as emerald, purple as amethyst, clear as diamond, others, creatures unknown to science, emit flashes of phosphorescent light with which they see deep down where the sunlight is dim. Little creatures cover leaves and rocks, others poise in waters deep, while minute crustacians, called sapphirinæ, "ocean sapphires," in such numbers it seems as though the Almighty's lavish hand had strewn the waters with costly gleaming gems. Then

sweep by small schools of jelly-fish, crystal vases, moon-shaped bodies, so clear, so delicate the rich colored ocean forms can be seen through them. While we look they change their colors to steely blue. Some are like specters, lace traceries, others rich in colors flaunt behind them long trains a thousand times more beautiful than ever decked a queen.

Now the glass comes over a giant physophora, nearly 6 feet in body, white-blue with dark chocolate lines radiating upwards, while from below swing the magnificent flutings of the tail. The whole creature is made of jellylike substance ablaze with colors, pink, blue and quicksilver, as it pumps in and forces out water to drive itself along—a veritable floating pump, a soft yielding form, living in this ocean paradise.

Now the boat is over 40 feet of water, blue and clear as the California sky above; down deep the kelp leaves are faintly outlined, but the waters are filled with living forms. Here live the sheepshead peculiar to the region, the male with enormous red and black stripes, blunt forehead and white lower jaw; the female is a beautiful creature, flashing eyes of red, brown and white and striped like her mate. A little bait was thrown in and they came near our window in schools.

We are now over still deeper waters, and a great flock of barracuda, thousands in number, pass under us, their long, slender bodies wave like eels, their long, pike-shaped heads all point in the same direction. Soon they vanish as though some shutter had been snapped or our window closed, for a great fish darts towards them to get his supper. Now comes another school of different fish—new panamoras of marine scenery opens out beneath. See these perch darting in and out the glades of the kelp forest below to get their food, then come to the surface to bask in the sun. Rock bass poise on long leaves of kelp striped brown with blends of green stripes; here and there are radiant white fish, and other forms as blue as the water. The scenes vary from deep to

shallow waters, new wonders opening out at every turn.

We are surfeited with sights. The brain is tired, the mind is weary, much more than when you pass through a vast Museum of art, sculpture and paintings. We have been looking down into ocean depths, where we saw the wonders, the indescribable beauties of God's Museum below sea surface, in waters deep into which few eyes have penetrated.

As we turned back the scenes were repeated, new marvels were found, exclamations were repeated. On Avelon's sandy beach we talked to those who stood there, of what we saw. Some parties heard us and asked the man to go out with them. "No, I will not go out again to-day," he said.

As we could see only about 60 feet down, beyond that the light became dim, we would like to know what is below in the deeps. Beyond where sunlight penetrates all is dark as midnight, but there untold and uncounted species of creatures live. Each has a lamp which lights for them the everlasting gloom. The wonder is these lamps give a pure white light without heat. For ages man has tried to get light without heat, because most of the energy is lost in heat, but to the present time we have failed. The great Engineer of nature solved this mystery when he made these creatures. Many creatures have electric storage batteries, as the electric eel which will shock a horse to death. We thought the discovery of electricity was a wonder, but it was in nature before man dreamed of its existence. Let us see what is below as far as man has penetrated the deeps.

The deep waters of streams, lakes and ocean cover a wondrous world of marvels we hardly ever see. De Plury invented a metal armor, which enabled him to go down into the sea 336 feet, and describes what he saw. Everything seen through the water appears magnified. At nine feet the medusae begin. Little lower schools of small fishes are found in a state of continued vibration, scintillating like burnished silver, copper and

brilliant jewels. At about 162 feet thick masses of seaweed with arms from 60 to 90 feet long, and hairlike, matted together, enwrapped the body weighing him down and hindering his movements, even endangering his life.

Below were met numerous snakelike fishes about three feet long, and other creatures like dolphins, which hurled themselves against the diver, but his armor and the four-inch thick glass before his face protected him. When deeper the polypi or devil-fish wound their long tentacles round him, but withdrew when they touched the metallic coverings of his protecting dress. Deeper were found giant crabs, three feet across, which, with their formidable claws could crack any bone in his body as you would a parlor match. Farther down came strange deformed creatures made to live in the deep oceans and indure its great pressure. All these are carnivorous—living on other animal forms of life. At a depth of 204 feet the pressure of the water is 88½ feet on each square inch of the human body, whereas at the surface of the sea the pressure of the air is only about 14 pounds.

Plants or fishes living down fathoms deep when brought to the surface die, because the waters or fluids in their tissues, at a tension to stand the great pressures, burst their organisms as soon as they are brought to the surface. Down deep along the ocean bottoms the sunlight never penetrates. But these creatures have lamps which give out phosphorus light, which enables them to see and procure food. We think our lights and lamps are wonders, and the electric light a marvel. But what are these compared to these the lights the Creator made?

The light changes with the depth, blending green and blue like the Azure Grotto, opening into the north side of the Island of Capri, Italy, or like the deep caverns seen in icebergs. At a depth of about 100 feet the light gets dimmer, more diffused, the sun seen up through deep ocean waters looks like a reddish opaque globe, and in the shades of rocks the stars are visible. Standing on a plain of white sand bottom at noon, the reflec-

tion from the white carpet gives the impression you are standing on a plain of molton gold. At 226 the darkness is dense like twilight, at 326 the gloom is inky black the electric light is used, a lamp of 10,000 candle power throws the light only within a radius of 90 feet.

No scene of horrors can be compared to that of a wrecked ship, lying there on the sea bottom with broken boats, splintered decks, crushed hulls, gaping walls and broken masts—tombs of sailors with every bone crushed, the bodies lying quite flat being devoured by giant crabs and strange denizens of the deep. Every object at the bottom of the sea is covered with a kind of powder as there they lie in the deep gloom and everlasting silence. If you touch a body not eaten by the creatures, the flesh will fall from the bones leaving a horrid skeleton.

Above and below at all depths are living creatures—some plants, other animals, each species with its own peculiar way of procuring food and propagating its race. In the dark depths where no light penetrates these creatures have special organs which give out light, a kind of phosphorescent glow like the fire-fly which gives them light. Down to lowest deeps they are found. The trawl of the vessels sent out by different nations bring them up from depths, deep as our highest mountains rear their heads in air. There, where man will never penetrate, never see their beauties of form, figure and color, God scattered life when he said, "Let the waters bring forth the creeping creature having life . . . and God created the great whales and every living and moving creature which the waters brought forth according to their kinds." Gen. i. 20, 21.

SECTION V.—THE WONDERS OF HUMAN LIFE.

CHAPTER XX.—THE THEORY OF EVOLUTION, WHAT ARE ITS FOUNDATIONS?

Evolution supposes that matter, directed and controlled alone by the laws of nature, condensed into orbs, suns and planets; that dead matter gave rise to lower forms of living beings; that during vast periods of time these lower forms by natural laws evolved into nobler kinds of plants and animals; that beasts have reason differing only in degree from human reason; that by natural selection and contests the lower beasts and plants rose into the higher; that at last they produced monkeys and apes; that from some kind of a monkey or ape, called the "missing link," man was evolved; that, first a savage, man civilized himself and developed into the modern cultured races.

The first evolutionists taught this was the way God made the various species of plants, animals and man. But their followers now hold that matter is eternal, has the germs of life; and nature alone, without God, formed the universe as we find it now.

The world looks up to God as Author of nature—Creator and Director; we supposed we were made to His image and likeness, therefore we held every man in honor and esteem. But this new theory tells us our forefathers were gibbering monkeys, or disgusting apes, that we are only brutes, that material universe only is; that death ends all, and that ideas of God and the future life are delusions, relics of the ages of ignorance.

Scientific men, especially physicians, knowing only a part of human knowledge, get brooding over one or two

ideas, think on these things till they overpower them. A sign of mental weakness is found in a person when he cannot get rid of an idea. Our insane asylums are filled with people sane on all things but on one or two points, especially religious questions—but the moment you bring up one of these off they go. Many people get insane on evolution, religion or a scientific theory. Then they write books to prove their theories, make money and obtain notoriety.

The greatest living evolutionist is Haeckel, of Jena University, who wrote many books to prove that life is nothing but the physical forces acting in plant, beast and man. A short time ago he was accused of forging pictures and documents and giving false discoveries of scientists to prove his theory. He came out in a paper he read before a learned society in Germany, admitted he had forged these documents to mislead his readers but excused himself saying all writers on evolution did the same. The account ends with the words "Haeckel is done for."

Here you have the key to the writings of these men. They forged and falsified deliberately to mislead millions. But how few will hear of the forgeries! Infidels have been doing the same for the last half-century, while the world covers them with glory.

Not one of these men is learned outside his special studies, yet each wants to solve the deepest problems ever proposed to human mind, thinking they "know it all." Darwin, whose statue adorns the great stairway at the Kensington Museum, made his scientific studies at Christ College, Cambridge, where he did not take the full course, but confined himself to science, learned about all he knew during a voyage at sea. He fills his books with false and unauthentic information trying to prove man came by evolution. Huxley spent only two years and a half at Ealing school, similar to one of our high schools, after which he studied medicine. Spencer, son of a school-teacher, never went to any school. Tyndall, educated by his father at home,

became a surveyor in Ireland, of which he was a native, and never attended any regular college course. So we might go through the whole list of infidels and find every one was an ignoramus outside his special department, yet they want to teach the whole world the whole course of human learning, falsify discoveries and documents and cite false cases to prove their outlandish theories. These men fall into a kind of insanity, even Spencer admitted before he died he was a little "cracked in the head," and continually suffered from nervous prostration.

But there is a method in their madness. They go to a dictionary, or professor of the classic languages, and manufacture bastard Greek and Latin terms to fit their theories. They use peculiar words to befog the mind lest their unreasonable theories may at first offend the reader. This is a trick old as literature, for St. Augustine complains of the infidels of his day stooping to the same methods of deception.

Huxley says: "Nerve forces are currents of electricity," when science shows they are absolutely different. Darwin in his "Descent of Man," writes, "Man is descended from a hairy quadruped furnished with a tail and pointed ears, and was probably arboreal in its habits." Herbert Spencer, philosopher of the theory, summing up his system in sixteen propositions—in involved sentences, faulty composition and words no human being can understand, concludes: "That which persists unchanging in quantity, but ever changing in form under these sensible appearances, which the universe presents to us, transcends human knowledge and conception, is an unknown and unknowable Power, which we are obliged to recognize as without limit in space, and without beginning or end in time."

According to evolution, God is the Unknown, Unknowable, cannot reveal himself to mankind, is one in Personality with the universe, is made of matter, is the Life living in all organisms. Human, animal and plant life are modifications of physical forces. Man

came up from beasts and there is no life beyond the grave.

Traveling in 1903 through the Orient, the writer made an extensive trip through Europe, and in France, to his questions received the following replies: "There is no God;" "The soul dies with the body;" "The universe was always;" "Evolution developed all things to their present perfection;" "Religion is a superstition, a relic of the ages of ignorance;" "We must destroy the idea of God in the hearts of all men and in society;" "Men and animals are machines run by physical forces;" "Science proves there is no God, no hell or heaven," etc.

What are the consequences of these teachings? Crimes multiply; murder, suicide, infanticide, dishonesty, embezzlement, immorality, divorces, crimes against person and property fill daily papers. The "Mighty Dollar" and pleasure are worshiped in place of God. The human race is drifting on rocks of infidelity, losing even natural religion, while every wild theory and "ism" have their followers.

While religion rests on foundations eternal in the mind of God, formed on truths He was pleased to tell us of His glories, scientific theories are so changeable and shifting, no one ever tried to found a religion on them to take the place of what they would destroy.

A kaleidoscope of changes takes place in the sciences —one theory follows another, till we are bewildered. Newton held light was caused by minute particles of bodies—a theory soon abandoned. The nebular hypothesis, given in a former chapter as a scientific explanation of the way the orbs were formed without an act of God, was accepted, when lo! mathematics and geology came in to show it false. A generation of naturalists once held coral islands were formed through ages by polyps, and now they say they are the tops of ocean mountains. Atoms and molecules ruled chemistry till wiser men and deeper studies show ether or extension and force are the foundations of matter. For a century

it was held the total amount of matter in the universe is unchangeable, this is now doubted. Sixty years ago Adam Smith was thought to have said the last word on economics, but now every one of his laws has been denied. Theories of inheritance, disease, bleeding, which killed Washington, chemical affinity, hygiene, medicine, and a bewildering maze of new theories come and go. The surprising part of it is that the scientist takes up or abandons these theories as he does a test tube, each wild hypothesis holds for a time till it is abandoned. For half a century, evolution ruled scientific minds, but now it is going the way of many an unprovable theory.

Materialistic views of scientists may be shown by the following. A professor lecturing to a class of medical students stated: "Here, in this jar, I have a little pig ground up. We can, by chemistry, put into this jar all these materials found in the pig. But we cannot make them live. Perhaps one day science will be able to give life to these materials, but we have not yet arrived at that knowledge."

Why did evolution spread so rapidly? Few are deep thinkers, versed in all branches of human learning, and people taken up with labors, gaining their livelihood, —do not go to the bottom of things. Any new theory always spreads like a fashion. But a plausible teaching which wipes out God, and our responsibility to Him, takes away the future state of rewards and punishments, the restraints of religion, opens wide the gates to all crime, touches each individual and will spread like wild-fire.

Evolution supposes mankind developed from the savage state to the civilized, but history tells us mankind first was highly civilized and by lapse of ages degraded into the savage. How many nations flourished and then fell into decay? Mankind in all ages hold there was a former state of happiness from which their fathers fell. This idea of a sure-thing progress upwards, that nature by evolution will lead to a higher

state, relieves Tom, Dick and Harry from present and future care and work, leads to optimistic fatalism. Fate ruled minds in days of paganism, is the foundation of Mohammedanism. Evolution is a new fatalism, induces men to laziness, destroys honesty, breeds atheism, would ruin every government and produce anarchy. For rulers rule with God's authority; destroy the belief in the Almighty, and we have anarchy, "no head."

Greeks and Romans, having dim, floating ideas of God and nature, held queer ideas regarding the beginnings of things and show how foolish people become when guided by reason alone. They thought all beings sprang from earth, air and water; Anaximander held animals were born of earth through heat and moisture, that mankind came from beings of a different form; Empedocles, that arms, eyes, feet and members of our bodies first lived separately, but united to make men and animals; Anaxagoras, that plants and animals sprung from earth, their germs floating in the atmosphere. All ancients supposed dead matter could produce life; the theory of spontaneous generation, that life can come from dead matter, the studies of Pasteur, Tyndall and great scientists have proved utterly false.

Aristotle explored human reasoning. He shows the mind grasps first universal thoughts, then particular thoughts, compares one thought with another and draws a conclusion. Deducing or drawing one thought from another, this is called the deductive method. Plato supposed these thoughts can exist separated from the mind. This deductive method ruled during the middle ages.

Francis Bacon taught us to study nature, observe things one after another, and from the observation of many facts of the external world find the laws governing them. This inductive method gave rise to the wonderful discoveries of science. But scientific men know little or nothing of the deductive method, soul, mind, or reason, and fall into many mistakes. Both

methods must be used to arrive at a full knowledge of nature.

After the revival of learning in the sixteenth century the investigations of Greeks, Romans, and Schoolmen were ridiculed and abandoned; the thread of human learning coming down from almost the origin of mankind was broken, and scientists, like men without a compass, got lost in unexplored oceans of error regarding man's beginnings, life, the soul, reason, religion.

Spinosa, the Hebrew, revived the pantheism of paganism and of India, teaching the universe is God. Descartes laid the principles of doubt. Buffon, contradicting himself three times, is vague and conflicting in his treatment of animal life. Then came men like Kant, Herder, Maupertius, Diderot, Bonnet, Robinet, Oken, who were followed by a school of materialists who see nothing but the natural forces in living organisms. German and French infidels paved the way for Huxley, Tindall, Spencer and the two Darwins, father and son. In our day Haeckel sums up the teachings of these infidels in his work: "The Riddle of the Universe," read extensively in Europe. A whole book would be required to reply to his false and unfounded statements. Let the words of Judge Grosscup of the U. S. Circuit Court of Appeals suffice. "I can state, I think, accurately and fully, the thread of his reasoning, and place against it the considerations that it makes to my mind are wholly inconclusive as a demonstration of the theory that man is wholly material—that mind and spirit are nothing but functions of matter."

Charles Darwin is the great apostle of evolution. In his "Descent of Man" he claims we came from a monkey because man and monkey resemble each other, that monkeys have a low kind of reason which differs only in degrees from human reason found among low tribes and savages. Therefore, mankind came from some species of monkeys. Since Darwin published his works, they have been looking for the "missing link,"

examining skulls and bones of apes and prehistoric savages, but not a sign has been found of that imaginary "link." Evolutionists think a large monkey's brain proves a man, whereas the difference is in soul faculties—the power of reasoning. Eminent men often have small skulls and fools largely developed brains. A man's brain is much smaller than that of whale or elephant, but the latter do not reason.

The theory rests on the idea that in former times man developed from the beast. But during historic days no signs of evolution have been found. No matter what food and care wild or tame beasts or cattle receive, or what struggles they pass through, they remain within their species. Within the species there are many families which developed from the original parent stock. There are hundreds of families of the palm species, and as many families of potatoes derived from the little tuber Columbus first saw on the coasts of Cuba, but these remain strictly palms and potatoes. From the little corn a few feet high of the Indians, by selecting the largest cobs for seed, many varieties of corn, some 16 feet high, have been developed, but they are always corn. There are about 100 families of dogs, the largest weighing 100 times more than the smaller, but they are always dogs and offer not the slightest signs of changing into other species. Neither history nor observation, therefore, offers the slightest proof of evolution. There is a "missing link" between each species.

Evolutionists claim that in the vast epochs before man was created the species of higher plants and animals developed. But in these vast periods of time no man lived who could give a record of the changes. Therefore there is not a single witness of evolution. It is simply a speculation, a wild theory resting on the air, existing only in men's imagination.

Records of geological times prove it false. Bones of animals, remains of plants of epochs before man we find in rock, sand and strata, are quoted often by

scientists. Plants and animals then differed from those now living. But each extinct species stands out completely different from other species. Between each species and the species above or below it there is a "missing link." We never found traces of the individuals uniting them with other species which we would if one species gradually developed into a higher. Each plant and animal of the geological species stands out, with leaves, trunk, functions, bones, shapes, organs differing from the remains of the individuals of species below and above. For example, a little horse with five toes lived at one time while now our horse has only one toe, called his hoof. But no remains are found showing the horse gradually left off, first one, then two, and three toes as the horse developed into our present animal. Every species of these far-distant periods stand out full and complete. The individuals died out because of different causes and new species were created. This is the only reasonable, common-sense explanation of the origin of species.

Examine the cell of living tissues—each cell under the microscope is seen, living, palpitating, endowed with life, contracting, expanding, bringing in and throwing out materials; each cell lives the life of the living principle animating the organism. If higher beings developed from lower they would make new organs formed of millions of cells. Each cell requires a new power to vivify and give it life. The lower being did not have these million powers to animate each cell and organ. Dead materials brought in by digestion do not have these newly formed powers, which could only come from the Creator of life. Evolution therefore demands that God is continually interfering in nature, creating millions of new powers, one for each cell, throughout the whole domain of living organism. This would require millions and millions of miracles being continually worked in nature. Can anything more monstrous and ridiculous than this be conceived?

How could low forms of beings living in water become fish, fish become birds, whales first live on land, then take to water and develop thick blubber to keep them warm? How could some primitive animal develop on one hand into the dog, and on the other into the seal, which has a dog-faced head, a rat become a beaver, largest of the rodent species, woodchuck grow into a bear, to which species he is related? etc. A thousand objections rise in the mind, but space allows us to mention only a few.

Scientific men having done wonders in modern times, while they remain within their own sphere of science all honor is due them. But as soon as they go outside their domain and touch on religion, reason, the human soul, God, and the future life they make fools of themselves. They are then in deeps they never explore. We must look at human knowledge in all its forms and departments to arrive at truth, not to science only, for that is only a small part of our learning.

God made angels, unseen, living, reasoning beings, free from matter, then created the material universe. He covered this little globe with plants and animals. Thus came forth the spirit kingdom, the mineral kingdom, the vegetable kingdom, the animal kingdom—the four great departments of created beings. Then he united the perfection of all these in one being—man.

Man is a mineral in the matter composing his body, a vegetable in growth, nutrition and birth of his kind; an animal in his bones, muscles, nervous system, five senses, internal sense and imagination, and an angel in his mind and free will forming his reason. In man all creation unites. This the Greeks dimly saw, for they call man a microcosm, "the little world." Last of the creatures God made, in him God united the four great orders of creation that here mankind below might image the Eternal. "Let us make man to our own image and likeness." Gen. i. 26.

By his material body, which is heavy, partaking in universal gravitation, man enters into relations with earth, sun and farthest star; by his plant powers he lives the most perfect vegetable life of earth; by his animal functions he is related to every beast; by his five animal senses he sees surrounding objects; by his reason he begins the order of reasoning beings, above him being deathless angel and the eternal reasoning God; by his mind he pierces down to material substances underlying forms and appearances clothing material objects; by his will he is free to choose the good, bad or indifferent; by his liberty he masters himself, his beastly passions—good in themselves but bad in their abuse. What fools they be who say man gained these from ape, beast or plant!

Therefore we find in man plant powers, many organs, and soul functions belonging to lower forms of life. Men who know little or nothing of man's highly complex nature, in their ignorance hold we must have come up by evolution from these lower forms of life, because we resemble plants, beasts, and monkeys.

Man is built, we might say, with four stories. The foundations are the minerals composing his body, formed into cells, composing organs placed and built into his body by the power of growth which stops when he attains maturity.

Man's next story is his vegetable powers, for the greater part beyond his control, which medical men call his involuntary muscles or the ganglionic system. These functions go on also during sleep, when they stop we die. Heart, lungs, digestive tract, etc., are examples of man's plant life.

Man's third story is his animal functions, muscles he can move, nervous system, brain, skeleton, five senses, interior sense, fancy or imagination, etc. In these he is an animal. He is the most perfect mineral, plant and animal in existence. These vivified mineral, plant, and animal powers run all through his system,

they are vivified by the functions or powers of his one soul.

His highest story is reason, uniting him with and raising him up to spirits of the unseen world, drawing him near to reasoning angels and to God. The five senses see particular truths of the surrounding world, but they can never rise above the one singular, particular object. Material objects are clothed in appearances which act on the five senses here and now. Reason, composed of mind and free will, the seat of liberty, grasps the universal, the general truth from these single individual truths seen through the senses. Above the single one truth the animal cannot rise.

Four chasms which nature alone can never bridge separate the ranks of living beings from each other: 1. Dead matter which can never produce a living organism; 2. Animals which have one or more senses and are animated by a nervous system no plant has, although we cannot tell where plant life ends or animal life begins in lower living forms of life; 3. Man has reason, that is, he seizes universal truths, while the animal grasps only particular truths. The particular is one, here and now, the universal is infinite in extent; for it may be applied to an infinite number of individuals as mathematics. No beast can see the universal; 4. Man is raised by grace up to a supernatural state. Grace is a free gift of God. This no animal can ever know or receive.

Scientists fall into the habit of treating living beings from a lower plane. They try to explain the lower forms of life according to the laws of dead matter, the animal as a higher kind of plant, and man as an animal. This runs all through their writings. They know little or nothing of living principles animating organisms, for they cannot see them, and they try to explain life according to the physical forces. During his course of medicine the writer never came across even a hint of the human soul, the mind, the faculties of the living spirit animating the body—whence medical men tend

to become materialists. They are called physicians, "naturalists," and give medicine they call physical, "to heal by nature." The spiritual part of man is never even thought of, for they know nothing about the soul. They try to find the place or spot where it lives or lived in the body, whereas it is an invisible spirit, whole and complete in each and every part of the body.

Living organisms, from lowest to highest forms, were built according to general plans. The foundations are cells filled with protoplasm. As they rise in the scale of species new faculties, powers, organs and structures are found in higher orders combined with powers of lower beings. But this does not show that the lower developed into the higher any more than that a "sky-scraper" developed from a one-story house without a builder or that one architect built both.

The most perfect way of building living organisms is along the lines we find living organisms are constructed. In no other way could materials be disposed so well to fulfil their functions. Matter could not be placed in other forms along any other lines and give the wonderful and varied life-functions. Therefore many organs and life movements of the lower orders are found in higher organisms. This has misled people who favor evolution to think that lower organisms developed into the higher.

Evolutionists hold oldest organisms lived in water and later changed to land plants, as the polliwog changes into the frog. But we see no change of this kind, and are we to suppose that at some remote time all marine animals suddenly took the notion that they would like to live on land and then got air-breathing organs?

Animals branch into two great divisions. Some have cold blood—their muscles are white, others are warm-blooded, their flesh is red. No warm-blooded animal can live without a gentle heat in its body. How could these beasts with red, warm blood change

from white flesh and cold blood to warm, red-blood and flesh? This difference is found in the very nature of the animals. The life functions are so different that at one stroke the supposed change destroys the theory of evolution.

Every plant and animal is most beautiful. A fly seen under the microscope is perhaps the most beautiful living animal. Its 500 eyes range like honeycomb cells, its body covered with hairs like a beautiful plush garment, it breathes through fine holes, its muscles are composed of little cells, some white, others red; each cell, like a precious gem, pulsates with life, its wings are gauzy films fitted for flight, which its muscles move nearly 2,000 beats a second. A book might be written describing a fly.

There are almost countless species of insects, each built on a different plan of beauty and perfection. How could dead matter of itself evolve such forms of beauty? Who is the Artist infinite in His knowledge of colors, proportions, with perfect taste, who planned and built these millions and millions of insects! Who gave them their instincts for the preservation of each individual and the propagation of their race? To say they came by evolution is unreasonable.

Animals divide again into two great series—one kind has hard bony structures covered with muscles, the other kind has flesh and muscles within a hard shell. Man and the nobler animals belong to the former, and insects to the latter. These two forms of structure are fundamental to these two great branches. If evolution be true, how did beasts develop along these lines so fundamentally opposed? The insect is a specimen of the shell form of beast, and the largest now living belonging to this series is the lobster. Examine the latter animal and you will get a good idea of the structure of an insect seen under the microscope.

At the present writing over 300,000 different species of insects have been found, but there are perhaps as many more species not classified; we do not know

their natures. How did these species develop according to evolution? If they came from one original species it would take countless millions of years to produce them according to the theory. How did these insects get from one continent to others after they had developed from other and lower species? They could not fly or crawl across the oceans and most of them live in water a few days. What good do these insects do? They are the scavengers of nature, many are most useful. They come from a "grub" chrysalis which first lives in an entirely different form from the parents, then pass through surprising changes till they come out full developed insects, which never grow as do higher beasts after they are born. How could evolution make this fundamental change in the birth of insects compared to the birth of other animals?

Over 7,000 different species of the fly, the diptera, live in the United States, and nearly as many more species in other countries. Nearly all are harmless, most kinds are extremely useful. "Any wholesale destruction among these species, if such were possible in the present state of our knowledge, would cause more diseases than it would cure," says J. Ritchie, Com. of the Boston Board of Health. A branch of the United States Agricultural Department devoted to the study of insects they dub "Bugology," and the reports are scattered in books and scientific reports in many languages. They are discovering new species all the time. The collection of beetles, Coleoptera, shows over 2,000 species; it is estimated over 3,000 species are in the Eastern States, over 2,000 species of moths, 2,500 species of flies, the same number of hymenoptera—wasps, bees and ants, 600 species of hemiptera—true bugs, cicadas, aphids, 125 species of cockroaches—crickets, locusts, grasshoppers and katydids, and 200 more species not studied. Together 11,000 species of insects are found in the six eastern States. But in South America, Africa and the tropics insects so abound that day and night they fill the air

with ceaseless sounds. It will take generations of men of study to know their species and habits. How could evolution develop all these different species?

About 50,000 species of insects have been described as living within the boundaries of the United States, few being harmful, most being useful to man. The mosquito stegomyia of the warm countries has the germs of yellow fever, putting the germs into the blood when it bites; the anopheles mosquito carries the germs of malaria and gives it to man; the tse-tse fly has a disease which kills cattle in parts of Africa, and another African fly inoculates people with the "sleeping sickness" which carries off millions of people. While 12,000 different beetles fly round north of Mexico, uncounted species live on other continents and in different localities, each with its peculiar ways of living and propagating its species, how can evolution give an account of the origin of these diverse species? It is simply impossible. The theory is absurd, unreasonable. We can only say "what fools these mortal be" to accept such a wild unscientific theory.

A drop of stagnant water under the microscope, shows thousand of living organisms, most of them unclassed, unknown to science, each having sets of nerves and muscles by which they move. They are as perfectly formed for their sphere of life as the higher animals. Their remains cover land and ocean bottoms. The diatom shells alone form the ooze lying on ocean beds, and compose hills and mountains. We find no signs of one species changing into another or becoming higher creatures. As the telescope tells the wonders of the sky, so the microscope reveals no less the marvels of a new world beyond unaided sight. Each structure is most perfect, of astounding beauty, showing an Artist made them.

How did plants and animals get these remarkable instincts guiding them to preserve the individuals and species, displaying wisdom beyond the ken of man? They show a science above the knowledge of the

wisest. Evolution says these are the acquired knowledge of the individuals of the species during former ages. This would suppose these had reason and transmitted the knowledge to their young. Darwin cites numerous proofs to show animals reason. He did not know himself what reason is—the grasp of universal truth. What he cites is simply instinct, the reason of the Creator directing life functions.

When we train animals their young know nothing of this teaching. You must teach each pup separately "new tricks," as you must educate the child of the most learned parents. When or how did birds get the idea of flying south in the fall, while others, like the sparrow, which can endure winter's cold, remains with us? Who told bear, woodchuck, etc., to put on fat in the fall and retire to winter holes; beaver and musk-rat to build huts in which to pass the cold weather; one kind of wasp to make its nest of crude paper and live in community like honey-bees, while another builds a single nest of mud; one kind of a swallow to make a nest of mud under the eaves, another kind in a chimney, while another species lives in holes it digs in sand-banks? Why do squirrels, crows, and beasts which live with us through the winter hide food in the fall, while birds which migrate to the south never lay up food? A thousand cases might be cited regarding plant and animal instinct proving evolution false, but they would fill a large book.

In the struggle for existence Darwin supposes the plants and animals would develop better individuals and species. On the contrary, in such a struggle the organisms would develop lower forms of life. Every farmer knows that poor food and want of care develop poor crops and lean, worthless animals. Plenty of food, careful planting and good care produce fine crops and fine cattle. The experience of every farmer proves evolution false.

In the plains of Texas, on the deserts of Arizona, in the waterless and bare valleys of Arabia, the writer

saw worthless dying cattle, famishing for food and water. If one will make a study, stop to think or visit these places he will see how false is the theory. Once the writer saw a caravan down in the arid plains of Arabia. He counted over 100 dromedaries, loaded with wheat on their way to Jerusalem. They were all great beasts—twice as large as the camels we see in shows. How did these beasts develop such proportions in the deserts? How did they get that extra stomach they fill with water that they may go for days without drinking? The only explanation is God made them for man's use, as "ships of the desert." Without them man could not cross these waterless plains. Why did not the American deserts, from Oregon to the city of Mexico, and down along the South American coast, west of the Andes Mountains, develop camels if evolution brought them forth in the Orient?

Evolutionists hold animal instincts were acquired ages ago by ancestors of men and beasts, and handed down to our day, as though dogs tell all their tricks to their pups, as though a learned man transmitted his learning to his children, as though if your grandfather was a great inventor you would be a genius in that line.

If organs developed according to the theory, men who ran much would begin to develop four legs, so when one pair got tired, they could run on the others; men would now be about twenty feet high; people who used their eyes much would develop one or more eyes; pigs and beasts with great appetites would get many stomachs like cows and camels; people who ate soft food would have no teeth; race-horses would begin to be built like deer, which are fleeter. The whole order of nature would begin to change in historic times; and where the struggle for existence became too great, man would revert again to the monkey from which they claim he developed.

But did mankind develop? Go to the Metropolitan Museum in New York and see the works of art dis-

covered in Cyprus, Egypt and the Orient. You will find men 5,000 years ago were the same as to-day. In the Museum of Cairo are the bodies of the Pharaohs of the Oppression—also that of the king who opposed Moses, known in history as Menephtah, whose mummy was discovered in the tomb of Amenhotep II, Professor Smith unwrapped his embalmed body. He was an old man and resembling in every particular the Copts of our day, children of the ancient Egyptians. His features are dark colored, hair reddish-brown, cheek-bones high, teeth a little irregular, brain large, head has no resemblance to an ape. There are many mummified bodies in this museum, and they show absolutely no signs of evolution.

The New York, British, and Cairo museums have paintings of people who lived nearly 5,000 years ago, done with art which would do honor to artists of our time. The forms and features are the same as those of people of our age. We went into the tombs along the Nile Valley, we saw scenes pictured on the walls, we found some with colors as bright as when sculptured—we walked over the sands which preserved them. We met people who look and live exactly like the men of Abraham's day, we found no signs of evolution, we testify no change took place in mankind for 5,000 years.

The general opinion of evolutionists is man was first a savage, because we find remains of the "stone age" over all the world. After this came "the copper age" then the "iron age." How can we account for this? Scientists are not historians. First from the plains of Babylonia the sons of Ham spread nearly over all the world. They used stone in every conceivable manner. Their weapons in war, chase and industry were stone-tipped arrows, spears, axes, knives, mills for grinding grain, etc. This is the reason we find remains of these weapons and utensils in great numbers in the countries these savage peoples colonized. They emigrated into every continent in prehistoric times, and

never advanced or made a single improvement till they mingled with the white men, the civilizers of the world.

The Caucasian sons of Japhet, the Aryans, "the nobles," went to the south shores of the Caspian Sea called the Caucasus. There they lived for ages before they emigrated to settle Europe and later India, whence a branch wandered to Japan. These white nations were always highly civilized. They are the progressive race, for to their father Japhet, Noe said: "May God enlarge Japhet, and may he dwell in the tents of Sem." Since that blessing, the white men have been overrunning the world, "dwelling in the tents of Sem." Every invention, every progress, every advancement of our race took their rise among the noble Aryan races. To-day we find savage races in the very same conditions as were the Hamite peoples who left remains of the "stone age." Devoted only to science many men never study history and fall into these mistakes.

The sons of Ham lived in the "stone age" down to our day. American Indians tipped arrow and spear with flint, used stone implements: the Esquimaux, Siberian and African tribes live in the stone age. The writer saw low degraded tribes in California, met the children of the Aztecs, "Cranes," in Mexico, saw the vast temples and tombs of Egypt, visited the great platform of Persia's ancient kings at Persepolis Alexander destroyed, he wandered over many lands, he saw the great collections of weapons and utensils in the Smithsonian Institute, examined the savage exhibits of the British Museum and of the Natural History Museum, New York, he visited collections of museums in many nations scientists offer as examples of primitive man and these are the works of the Hamites before the high civilization of the Japhetic white men came to "dwell in the tents of Sem" and Ham. They offer not a single proof of evolution.

If evolution is right, human nature is wrong. For

all men hold sacred human life. The care of the sick, the cemetery where we lay to rest our dead, the millions of plants and beasts we kill for human food, the sacredness of human flesh, the instincts of humanity guarding human life, all nations putting the murderer to death, the safeguards we throw round life and property, great calamities rouse the whole world, famines call out shiploads of food, sufferings of large bodies of people excite the sympathies of nations, while not a thought is given to the millions of animals we kill for food, for God said: "Behold I have given every herb bearing seed upon the earth . . . to be your meat . . . all the beasts of the earth and every fowl of the air, and all that move on the earth wherein there is life, that you may have to feed on." Gen. i. 29, 30.

Why that instinctive repugnance to eating human flesh but because it was not given us as food? Why men abhor the very idea of eating dog or cat but because they are like a part of the family? If evolution be true we are eating our brothers and sisters, for we and they came from the same original stock.

The world judges correctly, or human reason is wrong and mankind deluded till evolutionists began to tell us truth. If animals reason, as Darwin tells us, when a beast kills a man why not haul him up for trial, when a beast does damage why not make him pay, why not shut up the rest of mankind in asylums and let these men so wonderfully wise in their own conceit run loose?

Our space allows us not to enter farther into these questions showing how nonsensical, unreasonable, unprovable unscientific evolution is. Three theories have blinded mankind, each has not a single reason to rest on —the transmigration of souls from man to beast and back to man because of sins, atoms and molecules which mislead the scientific world since the French revolution, and evolution. The first poisoned the religions of India, the second destroyed, upset, or retarded the prog-

ress of mankind's conquest of matter, the third prevents scientists knowing the nature of life. The absurd, laughable mingling of evolution and transmigration of souls may be seen in the following poem, over which the writer worked for quite a time.

EVOLUTION.

You were a tadpole, I a turtle, in that Palæozoic time, when side by side, in the ebbing tide, we sprawled through ooze and slime: then we could skip, with caudal flip, through sea and Cambrian fen; in spite of strife, our hearts were rife, with joys of life, for we loved each other then.

In mud we lived, and soulless we loved, and then at last we died, and deep in the rift, of the Carbon drift, we slumbered side by side: the world wheeled on in the lathe of time, while hot heaved sea and main; but we caught our breath, from the womb of death, and as they saith, we crept into life again.

Then happy we lived, and still we loved, and then we died once more, our forms are rolled, in the clinging mould, of an old Menevian shore: eons fled, and ages sped, and sleep still wrapped us fast; but as they say, they were riven away, to a brighter day, and the sleep of death we passed.

With gills and lungs, and scaled and tailed, we crawled on strand, as black as a dead man's hand: croaking and blind, without a mind, we coiled at ease, neath dripping trees, and swam in seas of the past; then in the dark, we began to bark, till without reason's spark, we formed a language at last.

Then monkey-made, in light and shade, we swung in airy flights, or breathed the balms, of high-grown palms, in the hush of moonlight nights: and many the raid that we then made, as gibbering each to each;

all nature stilled, our life was filled, and how we thrilled, at the first faint dawn of speech.

With life through strife, to love above, we rose through cycles strange, from death through death, we got our breath: then followed the chain of change, till there came a time, in the mud and slime of the beach; till with a stroke, our species broke, and we awoke, with a thought of God to reach.

Like a Buffalo bull, we were tusked in full, and you my sweet, you were then so neat, all garbed in your glorious hair: we lived in the gloom, of a deep cave room, when night chased light from the main; while the moon o'erhead, lighted river bed, in the midst of our dead, we gnawed the bones of our slain.

Then I flaked a flint, to a cutting glint, and shaped it with brutish craft, and broke a shank, in the woodland dank, and fitted it head and haft: that spear I bore, to a reedy shore, when a Mammoth came in the rain; and all alone, with brawn and bone, I drove the stone, till I slew him with might and main.

Loud I bawled, as his flash I hauled, loud shouted our kith and kin, as from west to east, to the bloody feast they all came clamoring in: with cheek by jowl with every howl and many a growl, on that old Eozoic shore; it was a sight, to see that fight, as the flesh we tore and grabbed for more, then talked the marvel o'er.

Then all alone, with a big bear's bone, with a hard and horny hand, I carved his fall on a deep cave wall, that men might understand: how we used to fight, when might was right, and how we used to roar; that the age of sin did not come in, or crime begin, while we brutal instincts bore.

Years ago, when no men know, did change take place so strange? did all men find, both body and mind, in slime through toil and train: did our eyes, from a fountain rise? is our hair a horse's mane? were all mankind, one time pig-rined, and had no mind —is evolution sane?

Is our trail found still, in Tertiary hill, in the scarps of Parmian flaggs? Have we left our bones mid Glacial stones, in the deeps of Coral craggs? with all beasts slain, and from the main, just like the rain, will we rise born beasts again.

Did God sow our spawn, in the world's dim dawn, did He give us wings to fly? did he make our souls of rock-rimed rolls? for we feel our souls don't die; believe that nonsense if you can; how they rave o'er a new-found cave, or when some fools, with baboon souls, find some tools of prehistoric man!

CHAPTER XXI.—HOW A HUMAN BODY IS MADE, A WONDROUS WORK.

Man's soul has twelve powers or faculties, ten are buried in matter they raise up to live their life; two, mind and free will forming reason, exercise their acts without any material organ. We will first see the work of the ten functions of the soul and leave reason, mind and will for a future chapter.

Growth, (1) brings a man's body to full size and perfection, then stops; (2) nutrition sustains his body through life; (3) generative power being developed at dawn of manhood brings forth another like himself and ceases in old age.

Through his five senses (4, 5, 6, 7, 8) man sees surrounding material objects, these impressions he mixes and compares in his (9) inner sense, his fancy or (10) imagination reproduces these impressions and offers them to the purely spiritual (11) mind, which with them enlightens (12) the will. This receives them as good, bad or indifferent, and acts accordingly.

While ten soul powers buried in matter, furnish life to each organ and to millions of cells forming the body, mind and free will, pure spiritual powers of soul during this life get their impressions, or forms of material things through the five senses they offer the mind through the imagination, in the other life mind and free will live and get their forms for thoughts from God alone. There is another order of beings—angels living free from matter united with God, eternal Reason who created these beings, images of Himself.

God first made millions of angels to know love and serve Him. Some sinned, fell away from right reason and were lost; for liberty, act of the free will, may be abused; the order of creation was disturbed by the abuse of liberty, thus evil, the absence of good, came into the

world. A number of the spirits fell away, sank themselves into evil in which they freely remain as it were in a state of spiritual insanity, hating their Creator. But God will not be frustrated in his design of filling heaven with reasoning beings.

He prepared for another being with reasoning mind and will—man—more complicated, more wonderful than the angel. He first made matter we described in orbs wheeling round the universe; He clothed our little world with plants and animals, then united angelic power, mineral, plant and animal in one creature we call man, "reasoning being." "And the Lord God," Jehovah Elohim, "formed man of the slime of the earth, and breathed into his face the breath of life and man became a living soul." Gen. i. 26.

What a wonder it is to think that reason, mind and free will belonging to pure spirits, exercise their acts in a body built of once dead matter. But in nature no sudden chasm exists, man bridges the gulf separating visible matter from the unseen kingdom of spirits.

Men of old, though never told what these truths unfold, as still most people hold—glimmerings of the wonders of the human body uniting perfections of all creation came down from ancient days. Greeks called man a microcosm, "a little world"; Romans had the word humanum, "human," from humo, "the soil," and mana the Sanscrit, "mind," to reason, also mens: "mind," "to measure," for mind measures all natural things, whence English man and mind; Hebrews have Adam, "reasoning being," and adam, "red clay"; Egyptians had Pharaoh, "born of the sun," they worshipped as God from whom they supposed their royal family descended; Chinese claim their emperors came from heaven, theirs the "heavenly kingdom," their early king is worshipped in temples as Jos; Japs say their emperor is "son of heaven"; Peruvians supposed their royal family born of the sun to whom they dedicated great gold temple disks, worshiped each morning il-

lumed by sun rays. Thus all ancient nations preserved a dim tradition that God made man.

Countless individuals, plants and animals, each according to their species, are born, grow and die, descending from first organism of their species God made of earth as he made the first man. In each you find laws of chemistry, sciences of mechanics, of hydrostatics and hydraulics, of flowing fluids filling pipes, of standing waters seeping through membranes, of laws of light and heat, of motion and of movement, of construction and of building, of artistic groupings in beauteous forms, of blending shades and mixing colors, of just proportions and finest adjustments, thousands of things we yet not understand, are found in living beings, from lowest living forms to man most complicated. Mysteries of organisms show a reasoning Mind, infinite in science, built the originals, and now stands by directing constructions of all those that live to-day.

Silent in the dark, in deepest sleep of vegetative life, within the mother's vessel, in the greatest bony cavity of her body, heated with her gentle warmth, nourished with her blood and life fluids, day and night nine months go on life mysteries. The child knows nothing of his life functions, mother herself is ignorant of the wonders working within her, growth goes on till soul's growth builds his body of what were first crude, dead, earthy materials. A Spirit seems to stand by, a Scientist surpassing, an Architect-Builder pointing out to soul powers where to put the things according to the plans and specifications of a man, not of dog, beast or plant, because two men laid the foundations of human life.

Organisms with backbone come from egg fertilized by male element, and the moment life begins, cells pile on cells, string out from each other, millions in number range themselves side by side, end to end in magnificent groupings, in matchless mosaics, in beauteous forms no artist can imitate. All is beauty, harmony, regularity, till another man comes into this world and gets full growth made exactly like our original father Adam.

Each cell is animated by a power of the soul, has its own action, changes shape and position, moves muscles, thrusts out what it does not want and takes in materials in growth. Cell-center, called the nucleus, "nut," surrounded by protoplasm, like the yellow yolk of an egg, has its membrane clothing it, divides into other cells, and this way growth takes place.

The "daughter cells," first small, grow, divide, and produce other cells like the original. Waving minute hair-like processes surround the countless cells, bringing in nutrition, separating worn-out parts, acting like microscopic animalculæ we see in lower forms of life. Cells of the human body, each with life, can be seen only with the highest powers of the crystal-lensed microscope. Millions and billions of cells, of all sizes, kinds and varieties, form the human body. Each is different from another, each has its own place, end and object—each living the life of the soul. What, therefore, must be the nature of this spirit of man with its living powers, giving its life to each of these billions of living cells?

Under the microscope, each living cell flashes forth a most beautiful jewel, shining, sparkling—changing shades and colors as the light strikes it from different depths and sides.

Remember, reader, though during nine months a man is made now with all his wonderful and complicated machinery in his body, yet God made the first man and beast and plant as most astounding, surpassingly beautiful pieces of machinery, using every science now known, and many not yet discovered, that when the first organism and man's body were built, He breathed into these dead bodies living spirits with generative powers by which they brought forth others like themselves. So mankind and species of beasts and plants came down, till over 1,500,000,000 human beings and countless other organisms to-day live each constructed like the originals.

Keep before your mind, these men were built by the

ten powers of the human soul buried in matter, they raise up to live their own life; that all these materials are united into one body by the one spirit, which makes them one with it; that you represent your one spirit by the letter I, which stands for your one personality —for you are one human being composed of both body and soul.

The pure of heart should find no offense in the description of the way life first begins, for to make it plain we must begin at the origin of life. We can give but a few words on the growth of man before birth, and for a more complete description we refer to approved medical works.

Different growths, in the child, beginning with vegetative, go on all the time, we cannot describe them all at once, must take one after the other; these processes never stop till man attains his full stature, at about twenty-one years of age, when growth stops, while nourishing powers of soul continue till death.

The whole child is a development of the original egg membranes and materials furnished by the mother. With the exception of a few cells furnished by the father the child comes entirely from the mother; till it takes other food, the child is built from materials the mother furnishes developed from the original egg membranes.

Here we dip into mysteries of the greatest of the miracles believed by Christians. In Christ the egg was given life without any other element as required in human conception. Will you say God, who built the universe, founded nature we described, could not or did not do this? The miraculous birth of the God-man is not against reason, for the Holy Spirit, above the laws of nature, gave life to the ovum.

As the Virgin furnished the egg which developed along the lines we will describe, furnished all materials of growth and after birth milk on which Christ was nourished, his whole body, till weaned, came from her, can you suppose for a moment she had sin, even origi-

nal guilt? For if she had sinned Christ would have a body sinful in its origin. Medical science, therefore, proves the truth of the Immaculate, "Spotless," Conception.

Flowers have both male and female elements, pollen and stigma, most beautiful under microscope, the union produces a seed; lower animals germinate by budding, higher species have the sexes on different individuals, in place of the pollen and stigma of plant, beasts have living elements for generation; animals which do not bring forth their young alive have large eggs containing all the nourishment the young need, those which bring forth alive have very small eggs, and found, when seen under a microscope, formed as perfect as a bird's egg, the yellow yelk being inclosed in a membrane surrounded by the yolk, a covering of white albumen bounded by another membrane.

The human egg, about 1/120 inch in diameter, is surrounded by a transparent membrane 1/2.500 inch thick, inclosing clear albumen, like a hen's egg, under the microscope appears like a clear globe, bounded within and without by dark outlines—the two membranes, one holding the white yolk, the inner the yellow yelk—exactly like a bird's egg.

Within the yelk is the nucleus of larger cells, inside that the nucleolus composed of large granules and cells of different sizes. In animals which eat flesh the cells are more numerous near the membranes, and intermingle with fat globules.

At stated times according to the species, in higher beasts, in mankind, about once a month eggs, grown in the ovaries, come down through the tubes into the womb, the mucous membrane lining the latter comes off, the egg, after receiving life, lays on the blood vessels whence it gets its first nourishment by indosmose and exosmose. Animals serving for food have many eggs; eggs of fish are fertilized outside the mother in the water, in the mammalia and beings which bring forth alive and nourish their young with milk, the egg

is fertilized within the mother, and wonderful is the Creator-given instinct directing animals each according to its kind.

In mankind, highest mammalia, one side of the egg has a transparent hole from 1/3.600 to 1/5.000 inch in diameter, filled with clear fluid through which the life-giving germ passes, when the opening closes to prevent another entering. It penetrates down though the membrane inclosing the yellow yelk, through the interior nucleus to the nucleolus with which it mingles its cells and life begins.

The spermatozoon on the inner wall of the membrane inclosing the yellow yelk of the triton cristatus, a land and water living animal, has the largest germ. The human is about 1/125 inch long, flattened from side to side, looking like an acorn in its bur, with point like that of a rifle bullet for piercing egg membrane, while from its base springs a long delicate filament, like a tail, which waves and lashes back and forth like a swimming fish, so rapidly it cannot first be seen in the microscope, by which it propels itself seeking the egg.

The head is 1/6.000 of an inch long, 1/10.000 inch wide through flattened side. Eggs can be fertilized only by element of same species, instinct tells this to beasts, which mate only with members of their own race, showing evolution is a dream. All is harmony, beauty and astounding wisdom in nature, man only is injured in his origin. All is Wisdom's work. Hundreds of spermatozoa swim—instinct with Creator's wisdom, one finds germinal spot, pierces down through the membranes into center, attaches to inner membrane, mingles with cells, tail rests motionless, for nature's end is gained.

Now let us see what takes place in the mammalia or animals when the germ enters the egg. The egg is formed of membrane inclosing cells ranged beside cells, all filled with protoplasm but inert, resting motionless. The instant the life-giving element enters the egg, activity rouses every part and cell. New cells form

from materials drawn in by indosmose from mother's blood ; part is added to part, cells divide up into other cells, egg grows to womb walls, from which it receives its first nourishment. Surprising means are made use of to draw in these materials required for growth. Who directs these surprising operations going on there in the dark organ where life begins? It is not the mother, for her organ belongs to the vegetative part of her system over which she has no control. A mighty Wisdom stands by and directs these wonderful works of growth.

A gentle and continued heat must be there all the time. In this red-flesh—warm-blooded being—the womb of the animal is deep in the middle of the lower part of the body. If it were on the outside or in any other part of the body which could not expand with the growth of the young, the latter would die and the species become extinct. With what wisdom then the Creator made the organ where the young grow and are nourished before birth! How wonderfully food and air are brought there through the mother's blood! Who is so insane as to say this came from blind Nature?

Human soul and living principles of beasts have powers or faculties animating their bodies, these cannot exercise without organs, the moment what we described happens, a human soul develops from the life in the egg, but cannot use its bodily powers till organs are made. The real birth of a man, therefore, is not his separation from his mother, but his conception. "Thou shalt not kill" has no exception, to kill the fetus is murder pure and simple. Animals know this, for if you disturb a bird on her nest she mourns, for she knows life is in her eggs.

In the Smithsonian Institute, Washington, the beginnings of life in bird's eggs is shown in large wax models, from them we study human life. The germ on the inner side of the membrane inclosing the yelk divides by a membrane, the upper larger than the lower one is the beginning of plant, the other the foundations

of animal life of man. Again these divide into four, and again into eight bundles of cells, cells pile on cells, within a few moments they enlarge looking like a little yellowish-red raspberry. Fluids collect between them, bundles of cells separate them, in one place they become more numerous and granular, where they are attached to the inner membrane, these divisions, one plant, the other animal life, continue spreading through the system, for man is the highest developed plant and animal.

The whole human body is a development of the egg membranes. Every egg has two coverings, an outer inclosing the white albumen, an inner enveloping the yellow materials. They are called membranes from the Ethiopic bereana, "parchment," from the root barah, "to shine," "to be clear," "transparent." A membrane is a thin white flexible structure of fine network covering an organ like a skin.

The moment life begins these membranes begin a development by which they spread all over within and without the body, the whole body being made of these membranes. The outer membrane enveloping the white is now called the epiblast, "the outer germ," the inner membrane covering the yellow is the hypoblast, "the inner germ," between them grows another membrane named the mesoblast, "the middle germ," and another membrane called the holoblast or interoblast, "the membrane between." As the whole body is constructed of these membranes and male element the child will resemble both father, mother, and the race to which they belong. If parents are of different races, the child will resemble both races. Here is the work of a created soul, a living force, building, not orbs, crystals, or crude matter, but a human organism.

Fluids bring building materials and place them just where wanted. Here white yielding gristle lay foundations for future bones, there stretch beginnings of muscles to later move the organs, here are origins of

nerves, there the beginning of eyes, while near-by are the budding ears.

All through the body begin foundations of bones, little, flat, long, short, hard, soft, hollow; ends meeting ends of other bones; between them are uniting bands, ribbons strong as steel, each oiled between touching ends better than our finest machinery. A thousand canals, finely formed filaments, bundles of nerves made of millions of cells like little eggs, are seen, each having its own life function. All organs are put just where they are wanted, not one is useless; each has life built of crude metals till their unions make the organism.

It looks as though invisible hands reached out, took materials furnished by mother's blood, and reared a structure surpassing in beauty, reared in wisdom, and science far beyond the ken of all mankind. Who is this Creator of souls, this astounding Wisdom? Not the little child, for it always sleeps before birth; not the mother, for she knows not what is taking place within her. You may say it is nature, but what is that but another name for God? The young grow according to the general plans of species of beast or human parents; but who made the first beast or the first man from the earth? Who was the Author of plant, animal and human structures, living powers. Reason replies, the Creator. There is no other answer.

So fine and tender are the child's growing organs, they could not touch the mother; for their skin could not grow or blood circulate in parts pressed. A membrane, the vessel called the amnion, "a vessel," found in man and nobler animals, birds and reptiles, but not in fishes or serpents, begins to grow, small at first, rapidly increases, pushes out its edges from both sides at its union with the fetus, till they surround and inclose the child. It fills with a clear crystal water, liquor amnii, having about 1 per cent albumen, traces of urea from the child, and other salts. Thus

the child resting on nothing, floats in this liquid, is surrounded on all sides by this fluid, so its organism can develop. First, the child lightly touches the walls of the amnion, but about the fourth or fifth week this fluid increases, then diminishes a little. If you draw off this water, the child will die. This water is drawn off when the sack bursts at birth.

The mother's blood circulates not directly through the body of the child, for they are two separate, distinct beings, each having a perfect soul. The child gets its nourishment from its mother. There is an organ, as it were common to both, through which the materials of growth pass from one to the other. This is called the placenta "to unite together," which common people call the "after birth." It serves for the circulation of the child's blood and breathing. In the higher animals it has the shape of a disk, one side adheres to the walls of the womb, the other being covered by the amnion. Projections like leaves, and in which the blood-vessels of the young end, fill the whole interior of this organ. They end in minute vessels called the villi, looking somewhat like the blood-vessels of the lungs. The blood-vessels of the mother, belonging to the walls of the uterus, bring her blood to all parts, and these villi dip into them, but the exchange of blood does not take place directly for fine thin membranes stretch between them.

How does the child get nourishment, as the blood-vessels between it and its mother are closed by these membranes through which blood cannot pass? When two fluids of different densities are separated by an organic membrane, the materials of the denser fluid will pass through the membrane, till both fluids are of the same density. This action the Greeks called endosmosis, "impulsion within," and exosmosis, "impulsion without."

This is seen in the flow of sap in trees and nourishes all living organisms. In man and higher animals blood corpuscles are too large to pass through walls of blood-

vessels, but the nourishing materials of the blood flow through hair-like ends of the arteries, and run to all parts of the body, giving materials, as wanted or carrying away the worn-out portions. When cells and muscles throw out worn-out parts, they become poorer, thinner in materials, and by endosmosis new digested materials formed into her blood, pass into them, thus nourishing the child. The force of endosmosis and exosmosis even in a dead membrane is very powerful. But in the living subject it is controlled by life-forces, which places the materials just where wanted and in the right quantity.

Thus life-force builds muscle, bone, nerve, brain, and organs in all parts of the body, just where wanted, in the right shape, size and form. It builds up these members according to the race. It does not construct bone in eye, in brain, in heart or in lungs. Who ever saw a building build itself without a builder? Who puts the materials just where they are wanted? A power with infinite wisdom directs the process of construction.

In the meantime, egg-sacks have grown large, and look like two unequal sized hour-glasses hanging from the bottom of an overturned canoe. The enlarged egg yelk nourishes the child through the navel cord, the smaller canal develops into the intestines and the abdominal parts except the generative organs supply nourishment till the placenta is formed.

The child gets nourishment from these vessels formed of the egg, till about the sixth week, when they are absorbed. Animals which lay eggs produce very large yelks, having all the nourishment their young want, this is why they are large and very nourishing. In a most minute and interesting manner Agassiz and other Scientists with colored cuts, describe the development of turtle from eggs. Later, learned men studied birds growing from these membranes. Medical Institutes have wax models showing latest discoveries of the de-

velopment of animal life, and we find the child follows the same general laws.

Over the child remarkable organs are now growing, filled with blood-vessels. Eyes and ears show rudimentary forms, limbs shoot out as buds, and phosphates of lime begin to deposit as cells, looking like little eggs, where bones will be. The eighth week arms and legs appear in process of formation. Fingers and toes seem like little buds with deposits of lime. Where eyes will be are little capsules forming into lenses; ears are little holes and nerves and vessels are forming.

The egg membrane has grown into a sack studded with organs filled with nourishment, having arteries and veins running all through them uniting together till they end in the inclosed child, through the navel cord. This sack is the allantois, so called from the Greek allas, "a sausage." It is the agent of the first circulation of the blood, it brings to the chorion, "to hold," which surrounds it, wherein the child's blood is exposed to the mother's, from which it receives the nourishment and oxygen taken in when she breathes. After this the blood is sent through the chorion through a vein.

In some animals the allantois is a hollow projection simple in structure, but in man the allantois takes on a great development. A part below folds into the child's bladder, another part becomes the cord entering the navel joining child and mother. The chorion has numerous villi, in which the mother's blood circulates, intermingled with the child's vessels, branching like leaves of a tree; the chorion surrounds the child, the sack being filled with a water-like fluid. This is the condition about the third month, when the male and female genders can be distinguished.

From the child now floating in this clear fluid, at the navel a cord with two arteries and two veins rises like a stalk to the upper part of the womb, where it unites with the inclosing sack. Deep in the walls of this sack, leaf-like structures are seen into which the child's minute blood vessels branch.

About the third week, backbone bends over to make the head, down through the middle of the spine and head a fine membrane begins to form to divide the brain into its two hemispheres, later it continues down separating the spine into two canals. Thus the cerebrum "brain," proper, the cerebellum, "the hind brain," and the spine are doubled. But in the neck most nerves cross from one side of the brain to the other.

About the fourth week limbs begin to branch as buds, from long folds of the epiblast into which the mesoblast of the egg penetrates, the formations being extensions of the backbones. Soon the ends bud farther out into fingers and toes, first but faintly seen as notches, showing where the joints will be. The seventh or eighth week the mesoblast begins to grow into the muscles of the back, neck, jaws, and those inclosing the breast and abdomen, all develop from the same source. The last mentioned come out and unite about the fourth month to form the chest and abdomen.

The veins and arteries pass through three stages before they come to perfection. First they get nourishment from the yolk and white albumen of the egg, then from the mother's blood through the placenta the "after birth" through which the mother's blood circulates, after birth from the digestion of the mother's milk and the food passing through the alimentary canal during life.

The egg materials are at last absorbed into the body through the little navel which grows into the cord uniting the young to the mother. The heart at first is quite small, from it two arteries run out dividing into very small arteries, spreading the blood through the whole body, nourishing all the members, and returns through two little veins to the heart again. This blood is a rich fluid, having few or but partly formed blood corpuscles.

The mother's blood and that of the child flow side by side in the placenta, "to stick," or "mingle to-

gether." They are separated by a thin membrane, through which the nourishment and oxygen of the parent's blood pass into that of the child. From this placenta, two arteries come out, bend down, pass through the navel where the cord enters the child after passing through the heart artery, each passes down within on either side of the bladder, unite with the two branches of the great artery, a continuation of the aorta artery which bends over and continues down the backbone, inside, branching into two arteries to nourish the lower parts of the body and the two lower limbs—the heart-beats forcing the blood through these arteries and veins back again into the placenta.

Large veins come out of the placenta—larger than these arteries, and between the placenta and the navel they wind many times round this vein before entering the navel. The three blood-vessels resemble a rope with two cords wound round it. With their coverings, they form the cord uniting mother and child. Passing into the abdomen through the navel, this vein leaves the arteries and runs up to the upper part of the liver to which it gives out branches to build and nourish that organ, which is quite large before birth, as after birth, during life, it is the largest organ in the body.

Down along and near the backbone, beside the great artery, is a large vein. The blood coming through this vein from the placenta, empties into this, uniting with the flow of blood coming from the lower part of the body. Rising as a living flood, the blood enters the right auricle of the heart.

When our little man has lived about a month, the middle egg membrane, the epiblast, takes on a peculiar development, spreads out, folds as you would a leaf, the edges grow and come together inclosing a canal, which will become the backbone and spinal marrow. About the fifth week the divisions of the bones of the back separate by thin membranes, dividing them. The nerves presiding over animal life, now branch be-

tween them from the spinal cord. Bones begin to form as cartilage or gristle, at first they are very soft and thin in structure, till lime and mineral matters are deposited in them later.

The long canal down the back, first only a streak, is clothed with a thin skin formed of simple cells, extends from the end where the head and brain will develop down to the end of the body. In time this will be the spine and muscles of the back. Soon it divides into square blocks, separated by thin membranes, between which branch out the nerves of animal life, and those of vegetative functions. The blocks grow out on either side, their edges come together inclosing the great nerve of the spine itself, being inclosed by the membranes derived from the epiblast of the yolk and hypoblast covering the yelk of the original egg. This structure continues to grow till it makes the finished spinal cord, backbone, brain, head and the five senses. Thus is laid the foundation of the whole nervous system of animal life, from which reason will later draw its images.

Near where the epiblast membrane of the egg united the edges of its folds, as described, from the after part of the spinal cord nerve cells shoot out like buds, each the beginning of a nerve. In some lower animals they unite by fibers not seen in man. They are first of simple cells, but these later show diverse structures according to the different nerves they are to develop into, and the organs where they will end.

Epiblast, mesoblast, and hypoblast, thus grow into brain and spine which after six weeks growth look like an elongated lozenge with four points in the top; the two behind, twice as long as those at the sides, are covered with thin skin, outside of which grow gray matter forming cartilages, which become bones with organs forming round them.

The third month fissures in brain rise into foldings where nerves begin, and run down to the body. Two begin where optic nerves will run to eyes, and

two others to the ears. They appear in the cerebellum, "hind brain," about the sixth month; all these fissures except one, disappear the seventh or eight month, to form again and remain as brain convolutions, from which branch nerves controlled by will power during life.

Nerves from one hemisphere of brain cross over to the other side of the body through the medulla oblongata "the long marrow", an extension of the brain running down through the neck. This is the most deadly part of the body; to pierce it causes instant death. Animals which catch their prey know this; seize them by the neck and pierce the medulla with their long canine teeth as a cat catches a rat.

When the membrane closes the canal down the back —the spinal marrow fills the whole interior, the thickening walls of the epiblast inclosing it forms the bones and smaller nerves. First they appear only as swellings between what will grow into the bones of the spine. They branch along the back where the edges of the epiblast united to inclose the canal. They are first simple bundles of cells growing out like little roots; in some animals they are united by nerve fibres, but these are not seen in man. As these nerves grow their roots change places, shifting to the front. Then another set of nerves come out from the forward canal of the spinal marrow, and these nerves grow out like the others from the canal behind. These two sets of nerves grow out like limbs of a plant; in time they divide into smaller nerves, and still smaller, till they ramify to every organ, member and most minute part of the body, presiding over all life functions. One set belongs to the vegetable functions, the other system presides over voluntary powers of man.

While this is going on, other nerves push out from the brain to vivify its structures, bones and coverings. But special nerves bud out from the brain and become the nerves of the five senses—touch, taste, smell, hearing, and sight. As these five senses require a long description, we will leave the details for a special chapter.

The upper end of the spine has expanded into a bulb, and branched into three buds, or hollow dilations filled with protoplasm. The forward one grows into the front part of the brain, the middle into nerves of eye and ear—their ends become the organs of sight and hearing, the lower and rear buds united with the spine, develop into the after brain. The microscope shows developments of the egg membranes, and these are built of different cells. These three formations surround a cavity opening into the spinal canal down the back bone, the beginnings of the nervous system.

The epiblast and mesoblast egg membranes cover and spread through the growing brain—from these membranes the whole nervous system is constructed. While these growths go on, the upper part of the spine grows larger, bends over towards the front and becomes the forward part of the head. The outside egg membrane—the epiblast, becomes the outer skin, and external organs of the head, while the mesoblast membrane develops into the inner brain covering connective tissues, blood-vessels, bones, and structures.

The head is, therefore, an expansion or development of the framework of the body—the spine. About twenty-eight days after conception, the upper end of the spine, or backbone, crooked over at right angles to the spine, looks like the short handle of a cane, surrounding a hole which becomes the mouth; the bent-over end grows into the forehead, and from these formations the face develops. Mouth, nose, ears, eyes, cheeks, chin and organs gradually grow. The end first extends up high, but in time comes down and forms the top of the head.

The mesoblast membrane of the egg spreads with the other membranes, forms soft cartilage, which gradually absorb lime, surrounding cells like little eggs, and makes the bones of the head. Little by little, brain coverings, head and organs, grow from the three egg membranes, we described—the epiblast, hypoblast and mesoblast.

Each side of the forming head now buds out a growth looking like a hollow stalk with a vesicle or bulb. As it comes out forward, it branches into two growths with a bulb on each of its ends. These become the optic nerves, and the bulbs will be the eyes. As they come forward, they meet the epiblast egg membrane, which has been developing in all parts of the body. At the point of contact this membrane becomes thick, makes a depression like a little cup, the bottom bending in, and in this cup the epiblast develops the eye with all its wondrous structures.

Twenty-eight days after life begins, below, almost on the neck, on each side appears a spot or opening to the brain—these will grow into the nerves of hearing, branching from three origins—from the cerebellum, from the inner, and from the outer hearing nuclei from which it comes out, and divides to the vestibule and cochlea of the inner ear. These organs are not fully formed till after birth. Special nerves come out from the brain to the nose and tongue as these organs grow, these are the nerves of smell and taste—the latter being very acute after birth, especially for rich foods such as sweets, because the child requires much food while growing.

Six weeks after its creation the soul's power of growth has thus laid the foundations of animal life in the spine and brain, which after the fourth month grows rapidly so that at birth the head is quite large.

The great nerves, first formed of simple cells, later take on diverse structures as the organs are built. The spinal cord is a continuation of the brain, and has the same structure. From the brain branch two sets of nerves. One set, presiding over plant life, is called in medicine the sympathetic system, giving life to heart, lungs, digestive and reproductive organs. These nerves come down from the brain each side the neck, outside the spinal column. The other set of nerves comes down from the brain within the spine, and are called the spinal marrow. Each nerve comes from a certain

part of the brain, goes down beside but does not mingle with other nerves, and ends in an organ or muscle. The spinal cord or narrow is made of a great number of these nerves. It is like a bundle of wires each separate and insulated, going out from a central telegraph or telephone office to different offices throughout the country. But the force sent back and forth through these nerves is not electricity as Huxley says, but soul's nerve force without action on any electric instrument.

Especially between the backbones these nerves branch out to the organs, the forward ones supply movement to the muscles, the after nerves preside over sensation as heat, cold, pain, etc. Thus, when a man's backbone is broken he will have no feeling below the break, and he may live because his nerves controlling breathing, digestion, etc, have not been injured.

The outer membrane or epiblast inclosing the white of the egg becomes skin, bones, muscles and flesh. The under membrane or hypoblast grows, into the nervous system, spinal cord and brain, the mesoblast membrane, between these two, gives rise to the heart, lungs, liver, arteries, veins and digesting organs. Thus at the very beginning of man's life, he lays the foundations for his three fundamental activities—plant, animal, brain and nervous system his mind and will powers will use when reason dawns after the body is more or less advanced, between the age of five and seven years.

Growth goes on rapidly the first days of human life, much nourishment is wanted to push on the building, and blood-vessels first branch out bringing building fluid materials to all parts, to the organs developing from the egg membranes. Heart begins to pump blood, the foundations of the spine are first laid and the beginnings of the skeleton, its upper end becoming the brain. As life advances member after member form, all red colored, not green like plant tinted with chlorophyl.

The spine, like the keel of a ship, is first laid as the framework of the whole body, the bony structure, the spine, which upholds all organs of the body it begins to appear towards the end of the second week, when the egg divides into two parts. The upper end of the inner layer of cells bends over to inclose the brain. The cells multiply and pile up, forming a long groove down the back, which becomes longer and deeper as the cells multiply. The edges grow out, curve, come together and unite, surrounding the canal of the great spinal nerve. The growth begins in the middle of the back, pushes up to form the brain, and down to compose the lower parts of the back. Within the canal the nerves of the spinal marrow are developed, the brain and the spine being formed of the lining of this tube, while the covering develops into the skin of the back and head.

The upper end of the cavity which forms the spinal cord grows faster and larger than the rest, divides into three chambers which grow into the brain. The sixth week the canal of the spinal column divides into sections, the beginnings of the bones of the back, or vertebræ. Just outside them the central layer of cells of the mesoblast splits into two layers, the first to form the skeleton, muscles, skin and external parts of the body, while from the second the intestines, lungs, heart etc., are built, the space inclosing them becoming the abdomen and chest. The child has been growing larger and longer and the foundations of its organs in their varied foundations are laid. The sides bend towards each other so the fetus may be compared to a turned-over canoe.

About the fifth week the skin begins to form ; the outer skin being very thin, the child is all red like the inner parts of the mouth, because the true skin, that is the inner of the two membranes of which the skin is made, begins to develop first. About the fourth month fat first forms under the skin. The sixth month little projections or follicles appear in the skin, the beginnings

of the skin vessels which manufacture a cheesy, oily, lubricating substance which prevents injury to the skin when the mother moves if it touches any part of the inner lining of the water-filled sack. This oily substance becomes thicker as time goes on and at birth covers, lubricating the whole child, making birth easier. A similar thick mucous covers fishes and water animals so the water will not injure their delicate tissues; this is the reason they are so slippery.

About the third month finger and toe nails begin to grow; the sixth month they are seen coming out through the skin of these members, which are first quite small and short. Deep, minute holes are now found on the head, through which, about the fifth month, hairs come out which often drop off after birth to give way to permanent hairs. Sweat and fat glands now appear, the first cool the body during great heat, and the latter manufacture an oil which keeps the skin soft—these two vessels begin to grow from the mesoblast about the fifth month.

On the breast the mesoblast thickens on either side into blood vessels and tissues deriving its cellular structures from the epiblast. About the third month, in the middle of each a small projection comes through the mesoblast from which radiate tracts of tissues formed of long cells which become follicles, glands and ducts. The round projection grows out and becomes the nipple. In the boy the development of the breast stops here, while in the girl the growth continues into organs formed to secrete the nourishing milk for her child. The nipple in the case of the female grows larger than in the male, has numerous little holes through which the nourishment passes into the mouth of her child. It is composed of numerous muscles in round circles near the base.

We cannot give all the wondrous processes, growths and formations through which a man's body passes while he lives his sleepy plant life before birth. The details will be found in as far as they have been discovered in

medical works. Many scientific secrets have not yet been found, though medicine comes down from ancient Greeks, often new discoveries and organs as the science advances, are called after their discoverers.

Greatest, most wonderful of earth-living organisms, the human body is awful in death, a fearful horror pierces us at sight of the dead, for instinct tells we were not made to die. Well we remember scenes in the Medical College. Nude bodies lay on operating post-mortem tables, fearful was the stench, spite of "picklings," each took a part, leg, heart, brain or other organ, as with many a joke and jest they cut to pieces, never thinking there lay remains of a mother's darling, that was once a strong, healthy man; drink killed him. That once upright lively young woman, fell from honor with a gay deceiver, enticed from country village he deserted her, then the river and the morgue. Unclaimed bodies were sent to be dissected in science's interest. We left the study of the healing art, to take up the art of arts, the healing of the soul, —a nobler temple, made not to die, but to live forever in the sky.

CHAPTER XXII.—THE MECHANICAL CONSTRUCTION OF THE HUMAN BOBY.

The human body, formed of earthly materials, is united to a deathless soul which by its plant and animal powers raises up these substances to live its very life, is like a wonderful machine living the soul's life; while machines man makes are dead, this machine unites in one personality forming one individual man. With its plant powers soul in growth and nutrition makes cells of newly digested materials, throws out dead worn-out materials, builds and incorporates new cells in their place. Millions of cells forming the body, differ each from each, every one being informed by a power of the soul. There must be as many living forces or powers in the soul's plant powers as there are cells in the body—mounting up to uncounted millions. Some cells like beads string out one from another or lay in bundles making muscles, others compose membranes covering these, others group round holes making pipes, through which flow, blood, lymph and juices, etc., still others form white gristle at the beginning of life, in these phosphates of lime will deposit like egg-shells forming hard bones, through which blood flows in little pipes—the body a thousand organs made of cells each having its own use, built by an Architect who constructed living wondrous machinery of plant, animal and man.

Chemistry tells us man is built of 13 elementary minerals, 8 solids and 5 gases. The solids are carbon, calcium, phosphorus, sulphur, potassium, sodium, magnesium and iron; the gases are hydrogen, nitrogen, oxygen, chlorine and fluorine. It is astounding to think every man who ever lived was made of these few simple elements, and these compose the wonderful products of the animal kingdom.

These metals are in varied weights and proportions in the human body. A man weighing 157 lbs. has in pounds 88 oxygen, 14 hydrogen, 3.5 nitrogen, 1.6 chlorine, 0.2 fluorine, 44 carbon, 1.6 phosphorus, 0.2 sulphur, 0.16 potassium, 0.14 sodium, 3.5 calcium, 0.10 magnesium and 0.09 iron. These materials found in the bodies of men and of nobler beasts range, mix, and fuse in mechanical and chemical arrangements never found in nature. How any learned scientist for a moment imagines natural forces or lower forms of life could rise with unaided powers through evolution to build such an organism is beyond conception, except with the insane wish of banishing God from His creation, or how for a moment any one but a fool would accept evolution is surprising, except people like to follow a leader they think is wise.

The gases given above are very condensed in all living organisms, and are never found in these conditions in the mineral kingdom. If this 88 lbs. of oxygen in the human body were in its natural state, having the same heat, 98 of the human body, it would have a volume of more than 1,000 cubic feet while the 14 lbs. of hydrogen would fill 2,600 cubic feet. What mysterious power the soul of man and life of animal have to compress and keep these gases all the time in this state, when it takes cold more than 300 deg. F. below zero, using enormous pressure, to condense these gases which when released they return to their normal condition. We can only touch on the chemical and mechanical wonders of the human body. The great standard work, Gray's Anatomy, and hundreds of works on physiology, will lead the reader into interesting fields.

The heart is the great center of the muscular system, the muscles fit and work finer than bands running on our machinery; the bones, end to end, composing the skeleton of 208 different bones is the foundation of man's system; nerves branch out from brain and ganglionic system, some under control of the will, the latter

belonging to the plant system, the whole being a most wonderful chemical laboratory.

We have in us ropes, pulleys, pipes, belts, levers, mechanical devices of astounding construction; we are living machines our Creator constructed when He made the first man. With every movement we move a million cells. Each cell contracts, bulges out in the middle, dragging the cells to which it is attached, all uniting in the pull to move bone or organ.

Archimedes invented the lever men still use to move heavy objects, said if he had a fulcrum to rest on he could move the world, yet every movement of bone, muscle, vessel and organ of each creature is done according to the principle of the lever. What no man ever does, levers and muscles move soft parts on this principle. Examine a beef tongue, and you find it, especially at tip, composed of little levers in shape of muscles—thousands of these are in the body of all sizes, shapes and lengths. We put the point of a lever under a heavy object, rest it on some resisting object we call a fulcrum, pull down and pry up the heavy thing. But with few exceptions the lever is attached between the joint and end of bone or organ moved, so the limb moves faster than if the lever were like the one man uses. In no other way can the limb be moved so far and rapidly.

Put under the microscope specimens of unseen living forms swimming in stagnant water, from lowest bacteria to high developed rotefer with hairs on two spots on head looking like wheels, examine numerous species of diatoms and see their shells and muscles, see insect construction in countless species, look down at red muscles of fly, bee, wasp, etc., turn on highest powers and see these beasts filled with red and white muscles as levers running from shell, organ, member; see with what wisdom each organ is made for its mode of life. Then take up mechanics, the sciences and engineerings showing different machines, go through the human body, the nobler beasts, and see on what wonderful principles

these organisms have been built. When we see a remarkable machine which does wonderful work we ask, Who made it? Was not he a wonderful inventor? But who had such a knowledge of the lever so that He used it in the most astounding ways in these machines He made which live? Who will utter that blasphemy, there is no God? These organisms are made so correctly, fly, bee, dragon-fly, humming-bird, etc., not only fly so fast you hardly see them, but poise motionless in the air. What, therefore, must be the perfection of their construction.

The muscles, from musculus, "a little mouse," because so soft and tender, cover the bones and shape the body. They are divided into two kinds, one class we can move as we wish, the others are beyond our control. One kind is the voluntary, the other the involuntary or organic. One set of muscles is striped, the other unstriped. The former belongs to the animal part of man, the other presides over plant life. In man and warm-blooded animals muscles are red like blood, in cold-blooded animals, as insects, fish, etc., they are white like their blood and the sap of plants, which is vegetable blood.

Each muscle is a bundle of fibers clothed with a fine delicate sheath, seen in uncooked meat. Each bundle is a long roundish prism, composed of smaller bundles separated from each other by membranes. Viewed under the microscope the bundles are found made of round cells like beads on a string, the sides of each bead touching a cell above and below. The cells are like little eggs inclosed by membranes filled with protoplasm. They shine like little jewels gleaming in the light, each cell being like a pale reddish ruby.

Each cell has its nerve which moves it to contract or expand, and as they are united together the contraction makes the little string shorter. The bundles are from 1/200 to 1/500 of an inch long, hitched end to end, bundles lie beside each other, each inclosed in a sheath—

a great number make a muscle. At the ends they unite by strong bands to bones, forming framework of the organism, or to outside shells in case of insects; the lobster is the largest being with shell inclosing its white muscles. Each cell contracts to move the muscles, how we don't know; the united pull of all the cells move the organ. No system of ropes, belts or pulleys compare with muscles of living organisms.

Look at a stone-arched bridge, a high steel building with steel trusses to uphold weight, a great suspension or cantilever bridge; see how the engineers erect our big buildings, uphold the great roofs over a depot or construct a gothic cathedral and admire the wisdom of the men who planned these. But cut and put thick slices of bones, shells of insects under microscope, where these have to sustain heavy weights the principle of the arch is used, some cells are minute with solid walls, every building principle is there found, a thousand mechanical devices we have not yet discovered have been made use of. The principle of the suspension bridge was in nature long before man knew it. Where bones do not sustain much weight the cells are large, their shells thick, bones are hollow filled with marrow and blood-vessels run all through them making them pink-red in color. Will you hold no Mechanic built these structures?

Circulation of blood in man begins as follows. First appear two enlargements of the mesoblast, one the origin of the arteries, the other of the veins. They look like two little, long blood-vessels lying beside each other, soon unite into one when two arteries lead out from it, and two veins lead into it. In man and higher animals the heart is first hollow enlargements of the folded mesoblast, cells multiply till the membrane folds over to form an inclosed tube. This simple heart is seen in most fishes, animals living in water and in lower species of animals.

The cells of the heart and blood-vessels become large,

multiply, break down into blood corpuscles, other cells taking their places, materials of growth being protoplasm composed of fluids and gases in a fluid state. Blood corpuscles, very pale at first, look like white corpuscles, in the blood of lower animals and in man seem like white floating bodies. They get redder and flatter more and more like the corpuscles of the adult as life advances, but as soon as liver and spleen grow the regular white blood corpuscles appear. The egg circulation begins about the fifteenth day, and ends at birth when the child breathes.

The child's heart, formed of union of the two mentioned tubes, the moment of union, begins to bend over on itself in a ∩ shape, the middle pushes forward towards the right side, twists on itself, so the end from which the arteries branch is in front and to the right, that part into which the veins enter is to the left and behind, while the bent part divides by walls into three little chambers. The divisions go on till about the fifth week they grow into right and left ventricle, right and left auricle of the heart, the great aorta artery through which the blood is pumped out to the whole body, and the artery going to the lungs where it will be purified by the air, when the child breathes after birth.

This aorta, Greek of "great artery," coming out of the heart, rises up, bends over, and runs down along the backbone within. From the top of its arch two arteries shoot up to supply the brain. Branches grow from it extending to every limb and organ in the body. They send out pipes like the limbs of a tree. They divide into smaller and smaller pipes till they ramify into every part of the system bringing oxygen and nourishment. Passing through the minute network of vessels we see with the microscope, called capillaries, "hair-like", the blood bathes, washes and nourishes every part, organ, member and cell of the body. The blood brings to every cell nourishment, oxygen and what is wanted for life.

While blood corpuscles flow through the capillaries, they cannot pass through the walls of the blood-vessels. But the fluids of the blood flow out into the tissues through the walls by exosmose, the worn-out parts enter the capillaries by endosmose, and these two forces go on all over the body during life. If you obstruct the circulation the organ not fed by the blood will die, and must be cut off, or its decaying materials will pass into the blood and endanger your life.

The writer tied the leg of a live bullfrog so the web of his foot was stretched, and placed the web under the microscope. The blood could be seen flowing in its blood-vessels. With rapid beats it could be seen in the arteries, slowly in the veins, in the capillaries it was a gentle flow. The blood corpuscles could be seen winding along as they bent and folded passing the mouths of smaller vessels. Thus the life stream like a little rivulet wound round among the tissues.

Thus flowing along mid the tissues of organs of the body, the capillaries, from the Latin capillus, "a hair," like little pipes, many smaller than a hair, running through the whole system, even through bones, bring blood to all parts of the system.

The blood sent through arteries branch into smaller and smaller tubes till it nourishes every organ and cell. Then it comes back through another system of capillaries the beginnings of the veins. These get larger and larger rivers of blood like rivers become bigger as they receive more water. The veins end in a large vein which empties into the right auricle of the heart, passes down through a valve into the right ventricle, which gives a squeeze, sending it to the lungs, where it gives out carbonic acid, the blood corpuscles receive oxygen from the air, come back to the left heart auricle, pass through the valve into the left ventricle, is pumped through the system again, bringing the oxygen which unites with materials keeping up a slow fire which makes us warm. This circulation of blood goes on all the time,

so within a few seconds the blood passes through the whole body ever nourishing, warming, purifying.

The blood circulation through veins begins as follows. At the beginning of life two veins bud either side the growing heart, each sends a branch above and below, with short little veins on either side, fuse with others, then unite with primitive veins, while from below and above grow the central veins which with growth become the great veins. Science of water at rest—hydrostatics, "standing water," and hydraulics, "flowing water," is followed in all kinds of water-works men make. Before birth the lungs are solid, hard to penetrate, till filled with air after birth at the first breath. From the left heart auricle the blood passes down into the left heart ventricle, which squeezes with every heart-beat, and forces the blood up into the great artery called the aorta, which bends over and runs down the back along the spinal column. A large quantity of blood goes to the head through two arteries you feel pulsating in your neck, and this causes the large development of the head before birth. Before birth the pure blood of the arteries mixes with the blood of the veins, for the circulation is not perfect till the vessels are finished.

To every organ, limb and member, the blood comes from the placenta filled with oxygen and nourishment given up by the mother's blood. The arteries spread out, become smaller than the finest hairs, pass through little pipes, canals and passages you can see only with a microscope, bringing materials to build up the whole body of the newly created man. The blood-vessels give out life-sustaining oxygen, building materials to each part putting each kind wanted, in the place it is needed. Mechanics, science, chemistry, laws of physics—every science known to man, every law we have discovered, a thousand processes we do not know, laws of nature beyond our ken, a thousand wonders never to be revealed, go on there in silent darkness, in gentle heat till

a human body is built as the greatest structure in the universe.

Why does the living soul make there a brain, there bones, there a heart, two lungs, and the great liver, in another place? Why and how are these wondrous structures formed of the materials furnished by the mother's food? O, the marvelous structures as we see them in the microscope! Cells pile on cells, each filled with protoplasm, some larger, some finer, some of one material, others of different, each cell shines like a colored jewel, blending lights, polarizing light, changing in their glow as light strikes them from different sides, each having its own reason for shape, color, size and structure! Who is the Builder of this body? The human soul with its twelve powers, ten of which unite with crude matter, dead earth, condensed gases, it takes in and builds our body—one with it to which it gives life. And these marvels are seen not only in every human body, but also in every beast in a lower degree, and still lower in every plant. A Chemist wonderfully wise, a Scientist awful in wisdom, a Mechanic infinite in power, presides over the creation of every living being of our planet.

Rapidly beats this little human heart, almost 100 times a minute before birth, for growth is quick and demands much material for the building of a man. We have pumps to lift liquids, to force them through pipes, they must have valves to prevent the liquids from flowing back. But our pumps are mostly of solid metals while here is a pump of muscles, a living force-pump a thousand times more perfect than we make.

Cities are underlined with pipes bringing pure water, gas, electric wires and with sewers carrying away wastes, and we can force it up into our high buildings. Left alone fluids rise till they find the height of the original source. The ancients did not know this law, and built great aqueducts to bring water into their cities. If they had learned the wonders of the circu-

lation of the blood in the pipes we call arteries and veins, they could have spared the great expense of those long arched structures now ruined near Rome and other ancient cities. Veins and arteries, lymphatic, and vessels of the body have been built by a reasoning Power who knew the laws of flowing fluids long before man discovered them.

If blood in veins or arteries flowed back death would result in a few moments. But they have valves which prevent that calamity. The great vein ends in the right heart auricle and brings the blood which flows down into the right ventricle, a valve closes when the ventricle squeezes to send it to the lungs. It comes back through a pipe into the left auricle and passes through a valve down into the left ventricle. When this left ventricle gives a powerful squeeze to send the blood through the arteries, the valve between the auricle and ventricle closes. The left ventricle contracts with a more powerful force to pump the blood through the body, than the right ventricle, which sends it to the lungs. The left ventricle of the heart thus beats more powerfully to send the blood through the whole body, as this beat is better felt, most people think the heart is on the left side, whereas it is in the middle of the chest with the lower point turned to the left.

Valves to control fluids flowing in pipes, are crude, imperfect when compared to the vessels in bodies of animal or man. The inner linings of the pipes or little vessels enlarge into half round disks of endothelium. The long sides are united to the walls of the vessels, two disks being opposite to each other. When fluids flow the right way, they rise up letting it pass, when it tries to flow back this double valve closes, the walls of the pipe enlarge, the valves distend, their overlapping edges stopping the return flow. Arteries, veins, lymphatics and all the pipes of the body have these valves, each of a formation fit for the work it is to do. Who had such a knowledge of flowing fluids as to make these

pipes and valves, so different, so surprising and so perfect?

Arteries are composed of three coats, the outside being a protection to the other two, from which it is easily separated. The inner lining, formed of many-sided oval layers of delicate connecting tissues and elastic layers is built into a fine network in which the microscope shows numerous openings. In the large arteries it is very thick but quite thin in the smaller vessels. The middle coat of the arteries is of elastic and muscular tissues. When the heart-beats force the blood into the arteries they swell out and the valves close so the blood cannot return. The elastic walls, a thousand times finer than our best rubber pipes, close and force the blood along opening the valves to let it pass. The valves close and the contraction of the artery walls sends the blood on its way. Thus the blood passes along through the arteries, through smaller and smaller arteries with their contracting walls and wonderful valves, each adapted to the work till as a crimson flood it comes into the capillaries and bathes every part and organ of the body.

The veins have not as contractive a structure as the arteries, but are provided with a more numerous set of valves, and a wonderful formation to bring the blood back to the heart. Each pipe and member is wonderfully adapted to the work it is to do. We use rubber pipes yielding with pressure and contracting, but what are they compared to these pipes in our body, the living force built up in us, in animals and plants! And the wonders piled on wonders! All these pipes, as all members of the body, were made of the minerals of earth.

Who built this wondrous system of blood circulation where red rivers of life flow? The wonder still more wondrous is, that Power who created nature, who built millions of suns, countless species of plants and animals does not directly make this body but does a greater wonder. He made each living soul with its powers of growth and nutrition which build these organisms. He

who planned the mechanism of the stars on eternal mathematics, keeps these soul powers within their laws so the soul makes the body of a man and not that of a plant, dog or other animal. Let the student studying anatomy and physiology stop to think on the wonders of mechanics of chemistry and of the other sciences shown in the human body. Alas, our blindness! In the whole course of medicine the soul is never mentioned. God is completely left out of His most wondrous creation, the human body is treated as a dead mass of matter subject to physical forces, they never think of the absent soul.

Not less wonderful than arteries and veins is the lympatic system, from lympa, "water," having exceedingly fine thin walled pipes formed of three coats, also provided with thousands of valves of finer, more delicate, and different formation than those of veins or arteries, which stop the flow of returning fluids. No nerves have yet been found in lymphatic pipes proper but they are there, for all vital action depends on nerve force. But nerves are found at the valves, the latter showing a knotted appearance. The lymphatics are like an appendix to the blood circulation, for while blood brings food and oxygen to the body the lymphatics absorb and carry away the waste parts which would poison the person. Beginning in finest little pipes in most minute tissues, they unite into large and bigger branches, following the veins, absorbing by endosmose the gathered up waste materials and fluids, flow through them uniting into large tubes, which by two main ducts empty into the veins with the chyle of the digested food enriching the blood.

The fluid flowing in lymphatics, called lymph, is composed of water, albumen, fibrine, spirit extract, water extract, fats, salts, small round white globules similar to but smaller than the white corpuscles of the blood, and red corpuscles near where they enter the veins. A man weighing 140 lbs. will pour into his veins about 6½ lbs.

of lymph a day, part coming from food absorbed by the villi, the rest from materials absorbed through his system. The lymphatics system therefore not only gathers up worn-out materials but pours them into the blood where they are used over and over again.

Pipes bring water, gas, steam, etc., spread them under our cities, entering houses, going to different rooms, valves control the flow and sewer pipes carry away waste unhealthy materials. Aqueducts or large pipes come from reservoirs or gas tanks, get smaller as they branch out under streets and into houses, made of hard materials buried under the streets and plumbers, gas and steam-fitters put them in. Rigid dead steam and water systems heat our buildings, fire is in furnace below, heat comes up through the pipes. But few think of the wonderful systems of pipes in a man's body, without joints, bending with each movement, through which fluids flow all the time; we never look for a pipe-fitter to fix them, the fire is not in one place but in every part of the body, to which the blood in arteries comes bringing coal and air ever burning, keeping us warm. Who is this wonderful Pipe Fitter who built these systems, not only in man, but in every plant and beast?

What would happen if the sewer system of a city ceased to work? We have a sewer system most wonderful—so has every animal. Waste materials gathered up by the blood are sent along through veins leading through our kidneys, where they are sifted out in form of urea, for if they accumulated they would poison the whole body; and if these sewer pipes or organs refuse to work or work improperly we live but a few days, and you know how deadly are "Bright's disease" or diabetes, "a passing through," when the fluids change to sugar and soon kill.

Teeth tear or grind food so it will be partly digested by the saliva before entering the stomach. The child has at first 20 teeth, which become loose and should be taken out, otherwise the teeth which grow in

their place are turned aside and will be irregular. The second set, called the permanent teeth, 32 in number, 16 in each jaw, are incisors, canine, bicuspid and molars, showing man was made to eat all kinds of food, both vegetable and animal.

A tooth is composed of three different tissues, dentine, crusta petrosa and enamel. Dentine forming the greater part of the tooth, of 72% calcareous and 28% organic matters, consists of a firm substratum of minute six-sided rods lying beside, interwoven together, each rod being about 1/5,500 of an inch in diameter, between them being cylindrical canals about 1/12,000 of an inch in diameter, which with the dentine cylinders radiate from the nerve pulp up to the top and sides of the tooth covered with the enamel; as they rise the canals branch, divide and become smaller, increasing in number.

The central cavity of the tooth contains the nerve supplied with blood-vessels; this is the seat of pain when the nerve is exposed, or disease attacks it, the dentine also being sensitive to touch or pressure. The crusta petrosa, "bony covering," is a thin covering of bony tissue clothing the outside of the dentine in the roots which it unites by its periosteum to the socket. The enamel covering the crown, composed of 95% calcareous matter, is formed of superimposed layers of hardened epithelium almost crystalline, the hardest material of the living organism, resists the hardest steel and can be cut only with diamond or emery. It would be impossible to make any instrument to serve the purpose of the tooth in any other form which would serve the purpose as well.

The food passes into a pipe behind the windpipe leading to your lungs, the mouth of the air passage closes, or otherwise the food would go into your lungs, stopping air passages and smother you. Its mouth is lined with nerves exceedingly sensitive, and when anything touches them you cough. This arrangement of the two tubes

is seen not only in all nobler animals but also in birds. Why is this?

The windpipe is made of more or less hard materials which keep it open all the time, otherwise it would close and the creature smother. If the passage leading to your stomach were on the outside of this windpipe, when you swallowed a large mouthful of food, it would press on your windpipe, closing it so you could not breathe till it was removed or passed down into your stomach. This is but a sample of the thousands of Wisdom's marks shown in nature.

From mouth to lower end within the abdomen is the elementary canal from alo, "to feed," about 30 feet long in man, beginning at the back part of the mouth in swallowing organs which force food down into the æsophagus leading to the stomach, a tube leading out of the other end of the stomach being closed by a valve called the polyrus, "a door-keeper," which opens to let the digested food pass, stops the undigested and prevents food from the intestines returning. The tube below the stomach first small becomes larger. The tube from mouth to end of body differs in construction according to the animal.

A man's stomach, when moderately full is about a foot long, largest on the left side, is the pouch in which food is digested. Herb eating animals have many stomachs, the sheep having three, the cow a number, the camel an extra one to hold water while traveling through deserts. But man and animals which eat meat and very rich foods have only one stomach. Each species has an organ adapted by a Wisdom with a wonderful knowledge of chemistry. The stomach does not digest its walls because they live, and life force is higher than chemical action.

Four coats form the organ—a thick skin-like covering, an expansion of the peritoneum, "wrapped round," which covers all the digestive organs, a thick muscular covering of three fibers, some long, others circular with

oblique fibers running through them, and within a coat of loose filament tissues of mucous and muscular layers. These squeeze and move to mix the food with the juices thrown out from the interior walls of the organ. The stomach digests the food in the gentle heat and chemical actions of the organ. The whole interior is covered with mucous membrane you see in the mouth which lines its walls and all its organs.

Through the microscope this mucous membrane is found filled with minute shallow holes, each having six sides, arranged like a honeycomb, each cell being from 1/100 to 1/200 of an inch in diameter, separated by slightly raised edges. The bottom of each opens into little tubes, through which comes the gastric juice, so called from the Greek gaster, "the stomach." They are of two kinds—pyloric, "a gate," and peptic, "to digest," each system pouring out a different fluid. The pyloric are most numerous near the pylorus, through which the digested food enters the intestines, hence their name; while the peptic line the whole organ. Tripe, made of a cow's stomach, shows these organs. But in the human stomach they are much smaller.

Each peptic gland, "nut," like a cell in a honeycomb, turns on itself at the bottom and comes up like a little tongue filling the gland to within 1/6 of the top of the hole. The whole lining of the little sack is dotted with large round cells opening out, looking like little beads. They manufacture from the blood the peptic fluid and pour it out on the food. The pyloric gland is about twice as deep, the bottom also turns up like the bottom of a bottle, but the tongue comes up only half as high as those of peptic glands towards its mouth. The walls are of square cells, the openings of many tubes. The walls manufacture another fluid, which the pyloric glands pour into the stomach. These two fluids mixed compose peptic fluids which digest the food. When a person's digestive organs do not work properly, he takes pepsin, "to digest," made from an animal's stomach,

generally of the pig, rich in digestive fluids because of his enormously developed appetite.

After eating, the stomach first absorbs all the fluids, then these millions of little vessels pour over the food their secretions. The muscles of the stomach contract and expand, mix an outer layer of the food with gastric juices. Then they move this outer layer, now looking like cream, down towards the pylorus, which opens into the intestine to let this digested food pass, but closes against any food not properly prepared. A great chemical and mechanical change takes place in the food helped by the heat of the body. Every law of chemistry is followed, every principle of mechanics is guarded, each animal has his own way of digesting his food. Who made the different stomachs of man and of these animals? Who knew these laws and built these organs according to the principles of the higher sciences?

Down into the small intestines now comes the food, but it is not yet ready to become blood to nourish the organism. This intestine in man is from 24 to 30 feet long, longer or shorter in different species of animals according to the nature of their food. At birth it is about 9 feet long because the milk is already prepared in the mother's glands but grows longer during childhood. In the sheep it is 28 times the length of the animal's body, while in lion, dog and flesh-eating animals, it is shorter in proportion to the body than in man, because of the richer food or flesh they eat. Each animal has a stomach and intestines according to its food and mode of life. Who arranged these things for the nourishment of every living being from the microscopic diatom to the king of the universe, man?

Having been digested in the stomach the food passes through the pylorus down into the small intestine, where it is mixed with the bile from the liver, with the juice of the pancreas, " all flesh," and secretions from the different glands imbedded in the various membranes. The small intestine still farther digests the food, and there

the nutrition of the food is sucked up to be poured into the circulating blood.

This small intestine, about 20 feet long, gets smaller till it ends in the larger intestine, is divided into the duodenum, "breadth of twelve fingers," the jejunum, "empty," generally after death, and the ilium, "to twist," and because it supports the ilia, "flank," of the intestine. The ilium is formed of coils, or convulsions like a great worm, which moving slip over and press the food through it till it is emptied into the larger intestine.

The small intestine is formed of four coats: the serous, muscular, aerolar and mucous membranes. The first is a modification of the peritoneum almost entirely enveloping the organ. The second is of two layers of muscular fibers, the first thinly scattered over the organ along its length, the other winding round the intestine forming a thick, uniform layer. The areolar coat connects mucous and muscular tissues.

About an inch below the pylorus, or opening from the stomach into the intestine, the foldings of the intestine begin. They are from about two inches long, and 1/3 of an inch deep down to much smaller size into which the food enters preventing its too rapid passage, and giving a larger surface for absorbing the food. In the lower parts, where the pancreatic ducts enter, these foldings are quite large and close together, but from this part to the middle of the jejunum they diminish in size and numbers.

When the mucous lining of the intestine is examined with a glass, its whole inner surface is found covered with little hairlike projections, standing out on a velvet surface. They are called villi, "hairs," "fibrils," three-cornered, flat or round cylinders, with ends larger than their bodies. They are largest and more numerous on the inner linings of the duodenum and jejunum, fewer and smaller on the ileum and about 4,000,000 lining the intestine.

Each villi is formed of a central canal filled with milk-like fluid, surrounded with epithelium structure, blood-vessels, a basement membrane from which it rises, muscular tissues—all held together with lymphoid tissues. The central canal of each ends at the top in a lacteal: "milk gland" covered by a thin membrane. Its walls are formed of unstripped involuntary muscular tissues, surrounded with minute blood vessels and wonderful structures. These lacteal ducts are sometimes double in man, but in some animals there are many different kinds of villi, one kind differing from those of another species of animal, according to their food. The walls of the human intestine are also lined with other minute follicles, "little bags," small depressions in the linings of its surface, which when examined with a glass appear as minute dots on the surface scattered among the villi, the opening of each being closed by a membrane.

These millions of wonderfully constructed organs wave back and forth during life through the food, absorbing the nourishment through the membranes closing their mouths. By endosmose the nourishment passes through the membranes and fills their canals with what looks like milk, they pour into the pipes into which they unite. These canals, called lacteals, "milk-carrying," unite into larger canals called chyliferous vessels, from the chyle with which they are filled, and all come together and unite into a large vessel like a vein filled with the nourishment from the food, which empties into the great vein leading to the heart, where it is mixed with the blood. Passing into the lungs it is acted on by the air and becomes blood corpuscles and nourishing materials sent as blood to all parts of the body. When most of the food has been digested these vessels become less rich in nourishment, and hunger warns us we must eat again.

In 24 hours an ordinary man absorbs 143 gallons of oxygen, and throws out 124 gallons of carbonic gas, or coal in a state of gas. During his day's work a laborer requires 118 grams of albumen, 56 of fat, 500 carbon-

hydrates, 2,500 to 3,000 of water, the latter on a warm day; 18 eggs would furnish the albumen, 4 or 5 lbs. of meat or bread the carbonhydrates if not furnished by other foods. During this time his liver manufactures nearly a pint of bile which digests the fats; 5¼ ounces of pancreatic fluid, which resolves the bile digested fats into glycerine, changes the starch into sugar and the albumen into peptones which the villi of the small intestine suck up to be poured into the blood which nourishes the whole system. It reaches the millions of little cell-laboratories of which the organism is composed. Here with the help of oxygen the food is built into the different organs and the waste parts are thrown out, torn apart and appear as urea perspiration and gases in the breath. You might call them the sewers of the system.

These chemical actions cause the heat which keeps the body warm. The mechanical actions of the heart and of the other muscles add to the heat, that is why a person becomes heated by exertion. The amount of heat which raises a kilogram of water 1 degree C. is called a calory, and an ordinary man in a day produces 2,500 calories. This heat is changed into the movements of the muscles.

Your body is renewed in from 20 to 30 days—all the materials change during this time, although most people think it takes seven years. Food supplies the materials. A healthy person loses about a 12th in summer and a 14th of his body in winter during a day, working people losing most, which explains their large appetites. The loss is greatest between the ages of 30 and 40 and is less in women, children, the weak and sick. A vigorous laboring man will lose from 11 to 13 lbs. a day and must have food, nature tells him through hunger that he has used up the nourishment he extracts by his digestive tube and pours into his veins to be carried by the blood to all parts of his body. But there is a food we hardly think of without which we would die in few minutes, that is air.

CHAPTER XXIII.—THE FIVE SENSES—TOUCH, TASTE, SMELL, HEARING, SEEING.

Man and beast have five senses, like windows through which they look out on the world, through which they get information of material things. Some beasts have one or more sense higher developed than man, while another sense is defective, a dog has a powerful smell but poor touch, eagle an acute sight but bad smell, man alone has all the senses developed in a regular degree. The senses of each species of animal are developed according to their modes of living.

Through seeing, hearing, smelling, tasting and touching we perceive material shapes, sizes, hardness, softness, colors, movements, etc., we call appearances, as it were covering or clothing material things, these appearances alone act on the senses. But the substances so shaped, sized, hard, soft, colored, moving, etc., themselves we never see or perceive by any sense. Mind alone judges that under these appearances are iron, wood, gold, a tree, a mountain, etc., because the senses perceive the appearances natural to these objects.

Therefore we cannot grasp with any sense the substances of the 100 different primary metals or their combinations and unions which compose the universe, for we have no sense to see substance. What material substances are really in themselves no man knows. Wisest men say it may be ether pervading all space, underlying all metals, a dynamic source of activity causing these appearances to act on the senses, receiving extention from ether. There is therefore no objection against the Real Presence from the nature of substance.

Besides material substances there are living principles of plant and beast spirit substances, as human

souls, angels and God. Living substances, being entirely spiritual, have no material forms or appearances which act on the senses, and therefore we can never perceive a spirit by any sense.

We dwell in realms of spirits beyond our senses; all we know of spirits we get from reason and revelation. What is behind, beyond this material veil of matter we will know only after death. We live amid material things. Like animals, depend so much on sense so we find it hard to rise from gross matter up to a knowledge of the spiritual; for the human soul is sunk in a body of clay ever dragging us down so we incline to be beastly all the time.

Material things, therefore, are of two kinds—substances standing alone without the aid of any other, as air, water, silver, iron, wood, earth, etc., which exist in themselves, and appearances which cannot exist alone but adhere to other substances as color, form, weight, movement, shape, etc., which cannot be separated from things colored, heavy, moved or shaped. The latter are called forms, appearances, or modes of matter. The five senses grasp the latter while mind penetrates behind them and judges the nature of the substances behind them.

Nature is composed of material substances and forms and appearances, as it were, covering matter—that is, they hide the different substances under them. Man has five senses to perceive these appearances, and a mind which penetrates behind and judges the nature of material things clothed with form, color, shapes, weight, appearances, which act on the five senses. We can never perceive by any sense the material substances themselves. The mind alone tells us that such a thing is iron, such wood, stone or other things, because their appearances act in different ways on our senses.

Beyond the senses, therefore, are two kinds of substances, one the material, the appearances of which act on the senses, the other spiritual living substances which

have nothing to act on the senses. We never perceive life force in plant, animal, human soul, angel or God, for the five senses, being soul powers buried in matter cannot rise above their partly material nature to see the spiritual. We know a spiritual substance only by its works. We know God because we see His works in nature; we know a soul and living principles of plant and beast, because we see their work in their organisms. We see now objects with light, but in the other life we will see God with the light of His glory, another and higher light which human souls in this life have no power to grasp.

Science dwells in and occupies itself with material objects, their phenomena and laws, the senses tell us very little regarding the real nature of material substances underlying the appearances of material things. Touch shows us hardness, resistance, shapes, outlines, softness, etc.; taste is the sensation of the materials dissolved in saliva; smell tells us the odors of material solved in saliva; smell tells us the odors of materials, ether tremblings pass through the eye and form images of the objects illumed by light, but beyond this we cannot go while we live here. How limited then is our knowledge of nature, yet many men glory in science as though it was the sum total of human knowledge. The mind extends our learning far beyond the domains of sense.

The five senses man has in common with beasts are in certain organs animated by soul functions, soul raises them up to live its life senses function, only in these organs subject to disease and accident which may injure or destroy them. The senses give us knowledge of surrounding material objects, through them truths and realities of the material world pass as through five windows into a common soul power called the common sense, where impressions are compared one with another; these impressions pass to the imagination which reproduces, combines or re-forms them so we can im-

agine many kinds of material forms. Thus far animal powers go, but in man the imagination offers these images or impressions coming from the senses to the intelligence, from the Latin intus legere, "to read within," which reproduces them as general, universal ideas. Thus we think, reason; the mind offers these universal ideas to the will as good, bad or indifferent, and the will being the seat of liberty, man's freedom, acts according to the light of the mind. If a child were born without any of the five senses, the soul would be, as it were, shut up in a prison, and his education be almost impossible. When sickness, injury or any cause injure any part of this chain beginning with the nervous system through the senses, the mind cannot receive right impressions, thinks not correctly or man becomes insensible. In sleep the nervous system rests and mind is a blank or the person dreams.

Touch, "to thrust, or strike," the lowest sense is in the skin. By it we get ideas of weight, temperature, size, shape, smoothness, outlines, etc., of objects. Touch in the afferent nerves of the skin, the general covering of the body, ending in the brain, is more developed in upper parts of the body, its acuteness depending on the development of the arteries, veins and lacteals surrounding the nerves of touch.

Touch is most highly developed on end of tongue, that we may know when food is ground fine before swallowing it; at tips of fingers that we may feel; on lips and parts of mucous membrane covering forward parts of mouth, on nipples where sensory papillae and tactile corpuscles are numerous because of the nursing child.

In other parts of the body touch differs according to the development of the vascular system. Outer or upper skin, hairs, teeth and nails, having no nerves, have no sense of touch. Tickling is most easily excited in parts having feeble touch. Varying in different parts of body, greatest just where wanted most, touch is least between

the shoulders. It is very much developed in flying membranes of bat, in whiskers of flesh-eating animals which with them feel for their prey, and in members of the rodent families from a mouse up to the highest rodent, the beaver. Hands and tails of monkeys, lips and tongue of herb-eating beasts, end of elephant trunk and nose of pig, tapir and bat have an acute sense of touch. A person who loses his sight develops the sense of touch to a wonderful degree, because of the attention he gives to his sensations.

The tongue, chief organ of taste, on the floor of the mouth between the teeth of the lower jaw, is composed of muscles interlacing with each other in all directions. On the point the nerves of touch and taste are more developed than in any other part of the body. The mucous membrane covers the whole interior of the mouth and lips. On the under parts of the tongue it is thin and smooth, but on the borders it begins to change into a papillary formation.

The tongue papillae are projections of the dense network of fibers and tissues composing the organ projecting out of and covering the upper parts for two-thirds of its surface from the top backward. The back of the tongue where they end has from 8 to 10 large papillae ranging like a V. The figure has the point to the back, each from 1/12 to 1/20 of an inch across. The papilla is like a cone, the smaller end down, the top shaped like a saucer, the one at the point in the middle being the largest. Scattered over the upper surface of the tongue but more numerous at end and sides, are many smaller papillae—round, red, narrow where they are attached to the tongue—each growing up like a little mushroom. The whole forward part of the tongue is covered with smaller papillae—cone-like projections rising as little cones, forming a brush-like surface.

In flesh-eating beasts, they take on a high development as seen on a cat's tongue. If a lion would lick your

hand he would take off the skin. In larger papillae, and in most of the smaller, the nerves of taste end. They are formed of two kinds of cells, the outside being spindle shape, flattened, inclose a central bundle of round cells with a round nucleus in the middle—this structure being the taste goblet. These bodies are the seat of the sense of taste.

Taste, "to touch," "to try," is the sense by which we perceive properties of bodies, which undergo a chemical change in the mouth. The tongue is the chief organ of taste, although it resides also in the palate, its arches and other parts of the mouth. The fifth pair of nerves comes out from the brain, branches forward to two-thirds of the tongue, and to places where this sense resides giving sense of taste, while the glosso-phyrangeal nerve is the seat of disagreeable sensations, when extremely excited produces vomiting.

While taste is more acute in the point, base and sides of the tongue, it also resides on its whole upper surface being less marked on its middle. Nerves of taste and touch intermingle in the tongue and tell us things are sour, sweet, salt, bitter, or have compound savors, as cooked meats, vegetables, fruits, etc. Some substances, as alcohol, pepper, mustard, etc., are pungent and irritating. When hungry food tastes sweetest, for then we want it most, after a meal taste of food is less agreeable.

Taste was given to select good wholesome foods, which must dissolve in the mouth, otherwise we cannot taste them. For the food after being mixed with the saliva, must be absorbed by the mucous membrane. Within the tissues it acts on the nerves of taste. When the mouth is dry taste is imperfect. While eating the saliva mixes with the food, becomes saturated with it, and easily penetrates the mucous membrane lining the mouth, being aided in that by mastication. The full effect of taste is not perceived till the act of swallowing, when all dissolved the food comes into contact with the

nerves of taste ramifying to the papillae on tongue and mucous membrane. Touch, the lowest sense, requires only a contact with a body to perceive it, but taste, being a higher sense, perceives materials only after they have dissolved and penetrated to the nerves.

About the fourth week after the beginning of life the epiblast membrane of the egg, which bent over to form the head begins to thicken in two places where will be the middle of the face; the borders grow larger, the holes deepen and become two channels, which form the two nostrils, which can be seen at the end of the second mouth. The nose continues to grow till the organ becomes prominent at birth.

The nose is the organ of smell which gives notice of dangerous gases, which should not be breathed and aids taste in choosing food. The external organ has two openings extending up into large flattened cavities behind and above, deep in the bones of the face extending almost as high as the eyes. As dust would injure the delicate membrane covering the surface, many hairs grow just within the opening, serving as a sieve through which the air passes in breathing. The air passing up forms little whirlwinds within the large cavities of the upper part of the nostril, where it is warmed before entering the lungs. Many animals breathe only through the nose, never through the mouth.

The nasal flat cavities in the middle of the face extend from each nostril up and backward above the roof of the mouth to the base of the skull, then open down into the throat. They are narrower above than below, each opening into four cavities. From the inner eye orbit a little canal comes down into each nostril through which tears and water bathing the eye flow. A large canal leads into the back of the mouth and down into the lungs.

Holes go through the bones into the brain, through which the nerves of smell come out. Within and above they branch into many fine filaments, spread over a

third of the partition dividing the two nostrils and cover the walls of the organs.

The whole interior of the organs is lined with a mucous, "moist," red, membrane, being thickest over the bones and walls of the dividing wall separating the two nostrils. The protecting skin called the epithelium, "a bed covering," is composed of columns seen in the microscope, very fine below where most of the nerves end. There fine hair-like filaments, wave all the time, brushing the secretions down towards the openings, so they will not accumulate, sometimes they fill the nostrils and prevent smell. When a person has "a cold" the secretions are abundant, for then all the mucous membrane of the body "weeps" throwing out hurtful productions of the bacteria causing the trouble.

How do we smell? Bodies always give out minute particles, which float in the air. The amount of matter we smell is surprisingly small. A little musk, or attar of rose, will fill a room or house with scent for months, or years, without suffering a loss we can estimate by weight. Foods give out pleasant odors when hungry, some bodies give pleasant, others disagreeable smells.

The walls of the nostrils are always bathed in fluids secreted by the coverings. The minute particles are dissolved in these fluids, which are fresh in the upper parts of the nose. The first pair, or olfactory nerves, are endowed with the sense of smell, but cannot feel any actual contact of bodies. But the lower part of the nostrils is supplied by the fifth pair of cranial nerves, which cannot perceive odors, being general nerves of sensibility.

All vapors are not odoriferous. Some, like ammonia, chlorine, acetic acid, etc., are irritating, while foods, flowers, etc., are pleasant. Agreeable things have nice odors, and dangerous things unpleasant smells to warn us of their presence. Some kinds of animals, like dogs, never eat till they first smell their food, while others, as birds, depend on their acute sight. Man, depending on

his experience and mind in judging things, has not as highly developed smell as some beasts.

The dog, a hunter by nature, has a most highly developed smell, and animals he chases, have organs which give out odors, so a hound can follow the steps of a deer. A dog knows different persons by their smell, or odor of their clothes, and will find his master's steps hours after he passed, and bloodhound will find a criminal after he has smelled his clothes. Most wild animals have a most sensitive smell, and hunters must get so the wind blows from them to him.

Smell is on the end of the antenae of insects, flies which lay their eggs in putrid meat will not do so if these organs are removed. If their antennae are removed, bees, wasps and ants will taste honey mixed with strychnine and then stop eating. Smell varies in different insects; they tell members of their colonies by smell. The bees of each hive have their own particular smell, those born of a particular queen having their own proper odor, and they will kill bees of another swarm entering the hive. Workers, drones, honey, wax and food of each hive have their own peculiar smell, but that of the queen is the strongest.

The nobler animals, as dogs, horses, cats and timid beasts have ear lobes. They can erect, and turn them to catch sounds. Their ears are in the front of the head, while man's are on the side. Their ears are shaped to catch sound, and reflect it down into the opening. Bats have the largest ears compared to their size, and moles the smallest, yet the latter have acute hearing. Fishes and reptiles' ears are covered with skin, which prevents water entering and injuring the delicate structure. Fish are very sensitive to vibrations of water, but can hardly hear noises in the air. The ears of different animals show that a wonderfully wise Mechanic and a Musician of surpassing knowledge of sound and harmony made each organ of hearing best for the life habits of the animal.

Let us look a little at the human ear and see how it was made to enable us to hear. Sound and music were studied from before the dawn of history. Helmholtz, Tyndall and famous scientists unravelled the mystery of music, harmony and tone. Irregular beats or vibrations cause noise, and in the ear are three canals filled with fluid which receive all kinds of noises. Regular beats cause music, and the cochlea with its microscopic strings receive these regular beats. Nerves come out from the brain and end in these organs.

The ears each side of the head are the organs of hearing, each having an external, middle and inner ear. The external ear is composed of cartilage easily bent so a person can sleep on his side without inconvenience. It has a number of depressions and folds to deceive insects, and to lead sounds in through the hole which is about $1\frac{1}{2}$ inch deep, going forward and downwards into the bone. The ear holes are slightly curved, largest at the outer end, where a bitter wax is secreted to prevent insects entering the fine delicate organs of hearing, deep in the bones of the ear where they will not be injured.

The inner end of this canal is stopped by the ear-drum, stretched tight like the head of a drum, to receive the vibrations of sound. The drum, nearly oval, broader above than below, stretches inward, downward, formed of two very thin partly transparent membranes, connected with the labyrinth closing the inner ear by three little bones, the smallest in the body called the hammer, anvil, and stirrup, because they resemble these instruments. The hammer handle comes down between the two membranes of the drum, keeping it stretched to receive the air waves, which make the drum vibrate. These vibrations set the little bones trembling, and the stirrup, being attached to the drum of the labyrinth, closing the inner ear filled with a crystal fluid, sets this fluid in vibration, and these tremblings of the fluid act on the fine nerve filaments of the sense of hearing.

The epiblastic membrane of the egg thickens on each side of the growing head outside the third vesicle of the brain where the epiblast becomes deeper and thicker—sinking toward the base of the brain till it forms a flask-like cavity by its mouth narrowing. The mouth of the flask at last closes and thus within the soft bones the foundations of the ears are laid, building the middle ear and the tube from it to the throat. First pear-shaped, sunk in the mesoblastic membrane developed from the egg, as time goes on it develops the inner ear with its labyrinth, vestibule, canals, cochlea, drums, and other parts.

The neck of the flask or recess of the labyrinth becomes the aqueduct of the vestibule giving out buds from which the various parts are formed. The organ from the outer end gets longer, bending on itself within from left to right forms the cochlea, three other coats become the three canals, and the canal leading into the ear from the outside, closed within by the ear drum. The nerve of hearing, developing from the brain, divides into two—one for the vestibule, the other for the cochlea. The middle ear and the Eustachian tube are now formed and lined with the developed hypoblast and mesoblast membranes of the egg. The Eustachian tube leads down to the throat so the inner ear may be always filled with air. When it is stopped by a cold, or other obstruction, you cannot hear so well because the drum must have air on both sides to vibrate.

The three little bones in this air-chamber bring the vibrations from one drum to the other. The handle of the hammer hitches to the outer drum, being imbedded between its two membranes, and the stirrup is united to the inner drum. These bones dovetail into each other where they are united and magnify the vibrations.

The inner drum covers a little oval opening 1/5 of an inch in diameter, called the fenestra ovalis, "the oval window," which leads into the inner, or real ear, formed of the vestibule, three cannals and cocklea, all filled

with a clear fluid. The vibrations brought by the little bones from the outer to the inner drum sets this fluid in vibration.

Just behind the drum of the oval fenestra membrane is the vestibule, a central cavity common to the different organs of the inner ear. Above and behind it rise three canals of unequal length, flattened from side to side 1/20 of an inch in diameter, each forming nearly half a circle. They open into the vestibule by five mouths called by the ancients ampolae, "bottles," the mouths being larger than the bodies of the canals.

Below, and to the front of these three canals, the vestibule enlarges, winds from below up like a snail-shell, hence its name, cochlea, "twisted," "like a screw." It is a continuation of the vestibule twisted from below up. About a quarter of an inch in size, it is like a winding passage, one stage rising over the other, making two turns and a half, the circles getting smaller, reising like the coils of a snail shell. The organ is like a round cone with a large base and small top, resembling a rounded pyramid. A thin winding plate within called the spiral division divides it horizontally into about equal portions from the bottom to the top, following its windings.

This spiral plate or central division is broad at the bottom agreeing with the large base of the organ, but it diminishes gradually to the top where it ends. It reminds you of a winding stair with a large diameter at the bottom, but getting smaller towards the top, as though a little staircase was in the middle of a snail shell. But the upper part called the cupola, "top," enlarges like a little cup. This central division running from the base to the top, like a winding staircase without steps, is perforated by thousands of little holes through which enter fine filaments from the nerve of hearing branching from the brain.

Running up through the center of the organ is a round cone-like center, large below, small at the top.

Round this central cone in the middle of the cochlea, the snail-shell organ winds twice and half forming a winding passage divided into two canals by the central division. It looks very like a snail shell divided by a winding partition running from the bottom to the top, extending from the inside towards the outer walls to about the middle where it ends. It is found to have a remarkable arrangement of structures like the keyboard of an organ or piano, called Corti's rods, from their discoverer.

From these cells at minute distances from each other from 3,000 to 5,000 double strings stretch. They are continuations of the nerve of hearing which branch in two sets of lines making nearly 10,000 strings. Each double string making a V, each with a damper, the points unite with the nerve of hearing, the ends ending in the outer wall of the organ. They look very much like minute piano wires—that is, they form a double piano, the inner strings being more numerous than the outer.

The inner surface of the labyrinth is lined with a thin fibrous membrane similar to that covering all the bones of the body. A delicate process on its surface is attached to the bone, while its free surface is covered with a smooth pale layer of epithelium which secretes the thin, limpid clear fluid. See strings of piano, harp or violin, some small, short, others long and large. But the ear has these strings winding round within the cochlea to the number of over 5,000. What instrument has that numbers of strings! These microscopic strings are double, each has its own damper to regulate its length and time of vibration so as to catch every sound and tone. And these strings are double, making more than 10,000 in all.

Our musical instruments are dead, crude, unyielding. But this ear lives, moves, pulsates with life, grows without our knowledge, is nourished with blood and lasts us all our life. We have not to tune or repair it.

The living soul with its power of hearing made it without our knowledge according to the plans and specifications of this infinite Musician, who created man and animal. Let the reader take his microscope, turn its higher powers on the ear of man or animal, examine its structure, and if he knows the laws of sound and the mathematics of music, of harmony, he will exclaim: There is a God, for in no other way can we explain the wonders of the ear.

Edison invented the phonograph, "sound writing," in which air waves make little depressions on the soft cylinder which are reproduced when the hardened cylinder is turned. The stilus hitched to a drum rubs over these depressions, reproducing the sounds. In a more perfect way the little bones bring the air waves to the inner drum and set the fluid vibrating in the inner ear. Let us follow the sounds and see how we hear.

The handle of the hammer is united to the drum by its handle, both are free to vibrate, its head being connected with the anvil. The latter looks like a minute tooth with two roots spread out, the shortest tooth unites to edge of the bony mastoid cells by fibers, while the other root of the anvil, much longer, extends down behind in the same direction as the hammer handle and by ligaments at its top attaches to the stirrup. The foot of the stirrup is hitched to the inner drum closing the fenestral opening, against which the fluid filling the inner ear presses. Through these little bones the vibrations of the air making the outer drum vibrate are carried in and strike on the inner drum which trembles and this sets up vibrations in the fluid filling the inner ear, consisting of labyrinth canals, vestibule and cochlea with its microscopic strings.

The strings of a musical instrument will set the strings of another in vibrations when both instruments are of the same size, length, and tension. The cochlea has 10,000 strings, so that no matter what the rapidity, pitch, tone, timber or quality of music may be, one

or more of these strings will tremble in unison. The fluid vibrates and the little piano-harp or music-like instrument in the ear will thus hear them. Each of these strings has a little damper like that of a piano which comes down on it and deadens and regulates its vibrations. The strings end in or are continuations of the nerves of hearing, and bring the sensations of sound in to the brain, there they are received as sound.

The drum was perhaps the first musical instrument savages invented. Did the Creator know how to make a drum? We have two drums in each ear. A drum-head will not give out beats unless it be stretched, but the membranes of these little ear drums are stretched all the time. If they are broken we cannot hear.

The flute was the next musical instrument made, but the ear has three flutes—the three canals. In the flute a column of air vibrates, causing it to sound. But the fluid filling these three canals vibrates and these pulses act on the nerves of hearing, not only in the three canals, but in the strings stretching all along through the winding cochlea up to its top.

Many flutes of different size were gathered into the organ. But no organ can be made which the ear will not hear its diapason, hautboy, vox humana, etc., and every pipe in great choir swell and pedal organ. The ear can pick out sounds of wood or metal pipes from three-fourths of an inch long to 32 feet. Who made this ear founded on the mathematics of sound? Only within the last generation did scientific men reveal the nature of sound. But from creation a Musician who knew all sciences made ears of man and animal of wondrous structure to hear noises and musical tones.

Stringed instruments were made before the dawn of history, and harp, violin and numerous instruments with vibrating strings followed. But when we examine the ear with the microscope, we find it the most perfect stringed instrument ever invented. No human being could make an ear. It is a most perfect harp, piano, organ, etc., a combination of all musical instruments.

Nerves and non-vascular parts of the eye are formed of the epiblast membrane, while the vascular parts, that is the arteries, veins, lymphatics, etc. develop from the mesoblast. The most essential parts of the eye, the retina, lens and surrounding structures develop out of the epiblast.

From the forming brain each side the head first we see a cavity opening into the brain like a hollow stalk, which becomes solid forming the optic nerve of the mesoblast membrane. As it comes forward it meets the expanding layer of the epiblast, which thickens at point of contact forming a depression. The epiderm covers this cuplike depression, which recedes before it bending back like the bottom of a cup; between these two a little round formation grows, which becomes the crystalline lens. While the lens remains in the same place the cup becomes larger and deeper, and as growth advances the eye is formed in all its perfections.

The bottom of the cup formed of layers of the epiblast and mesoblast, as growth advances, gets larger and deeper, the bottom receding grows into the retina with its nine wonderfully built up layers of rods, cones, and structures looking under the microscope like mosaic pavements. The space between the lens and the retina, lined with the mesoblast membrane of the egg, now contains numerous veins and arteries. The iris, clear parts of the eye and surrounding structures make the eye into a round ball with a space or opening in front having a lens within clear as glass, through which the light can penetrate to the retina behind. Between the lens in front and behind clear water gathers filling the whole eye. Thus before the end of the third month an organ of the most wonderful construction is formed. Then small folds of the outer skin come together, cover the delicate organ to prevent injury, and before birth these separate and become the eyelids.

Let us see this highest organ of sense more in detail. The eye in its orbit is surrounded on three sides by

bones to protect it from injury. In man it is in front so he can look out on the world around him; being the world's master, he fears nothing. Birds and animals which cannot protect themselves have their eyes on the side to see danger on all sides. Man has the most perfectly developed eye, and sees clearly near and far. Although some animals see farther they cannot see so well little things near-by, or if they see little things they do not see so well at a distance.

The eyeball has seven muscles which direct it towards any point, is supplied by blood-vessels and nerves, and is sheathed with the two eyelids to protect its delicate construction as we would place a costly jewel or the fine works of our watch in its case.

The eyeball inbedded in fat is surrounded by a thin membrane clothing the ball which shows as the white surrounding hard coat protecting the organs within. In front is a round opening—the cornea, clear as crystal, through which you see the colored iris with a dark round hole in the middle. The light enters through the hole in the iris, passes through the crystalline lens, through where it falls on the retina, covering the whole interior of the eye where vision takes place.

The eyeball consists of two spheres of different sizes, the eyeball proper, and a section of a smaller sphere, which is about a sixth of the eyeball. The latter, being the clear part of the eye, rises, bulging out. You will see it better looking sideways at a person's eye. This is the cornea, "like a corn," for it stands out from the eye proper. It is formed of four dense, thick layers of elastic tissues supplied with minute nerves and is exceedingly painful when touched, as you find when anything gets into your eye. This, called the pupil of the eye, is as clear and transparent as the finest crystal, so the light can pass through it. According to the laws of light, when passing at an angle from a rarer to a denser medium, the beam of light is turned out of its straight path. The cornea being a part of a little globe, when

the light strikes it, except in the center, it is bent so as to pass through the round hole in the iris, and bent again when it passes into the clear crystal water filling the chamber between the cornea and the crystalline lens behind it, and still again by the lens.

When we take a photograph a diaphragm with a hole in it cuts off all the irregular beams of light except those which pass through the middle of the lens. The eye has a most wonderfully constructed diaphragm called the iris, "a rainbow," colored in different tints.

Animals have eyes and irises according to their way of living. Apes and monkeys have an iris round like man, and a highly complex system of veins, arteries, lens and retina. The hyena's iris is round like that of the dog, the bear's is oval like the woodchuck and raccoon, related to him. The opening through the horse's eye is a wide slit. Animals exposed to enemies, as the rabbit, hare, squirrel, etc., can see all around. The eye of the horse, camel, antelope, etc., have a black pigment curtain within which protects their eyes from the sun, and a membrane outside the eye which draws over the ball and rubs off any dust.

The iris of the human eye is a thin, round, colored curtain, hanging before the lens within, between it and the cornea suspended in the watery humor, having a round opening a little towards the nose, the inner borders of this opening lying on the lens, its outer edges being connected with the cornea. When we take photographs wishing to admit more or less light we use diaphragms, different with different sized holes. But the iris expands or contracts, with movements beyond our will, letting in just the amount of light wanted for clearly seeing. Circular muscles, forming a band 1/30 of an inch wide, close the pupil to the light and radiating muscles expand it.

The color of the eye is behind the iris composed of round or many-sided cells filled with coloring matter. In albino animals this coloring is absent, in blue eyes

the coloring is dark, but being behind the curtain it shows blue through the iris, while in brown and black eyes the color is in front of the iris. Before birth the pupil is closed by a delicate membrane, which divides the space in which the iris is into two distinct chambers, but about the eighth month this begins to disappear and only fragments of it remain at birth.

Right behind the iris is the crystalline lens, its transparent elastic capsule being surrounded by ciliary processes on its margin, into which it is imbedded like the lens of a telescope held by a metal ring round its borders. The capsule inclosing the lens is much thicker in front than behind. Before birth a branch from the central artery of the retina runs forward in the crystal water filling the eye from the retina to the lens, through which blood is supplied to the growing lens, but this disappears before birth when the eye is fully formed. The lens with its capsule is formed of clear, transparent, many-sided cells, the whole organ being as bright as the clearest crystal, when taken out shines like a diamond.

The lens, a double convex body like the lens of a telescope or magnifying glass, 1/3 inch in diameter, 1/4 inch through, is composed of concentric layers or plates; the outer layers being soft and the inner ones harder, forming a clear, tough, dense diamond-like mass. The layers are of small fibers lying beside each other, looking like six-sided prisms, or thin sparkling jewels when separated, reminding you of the prisms used in a lighthouse to catch the rays of light and send them over the surface of the sea. Their edges have processes like teeth fitting and dove-tailing into each other uniting one layer with its neighbor. They are about 1/5,000 of an inch wide, run from the outside ring of the lens towards the center, and curving round its edge they end where another prism begins, none of them extending to the center of the lens. Laying thus united together they form three coverings over the whole lens inclosing the hard center within.

At birth the lens is nearly round, as age advances it becomes flatter—on the surface behind more than the forward surface, in old age it is still more flattened, and slightly opaque which is the cause of partial blindness. The lens gathers the rays of light on the retina within, as age advances it changes its shape and people become long sighted and have to use glasses to correct this defect. When the eyes are much used to see things near-by, or overstrained, a rush of blood makes them larger, developing each part of the structure, as the hands of a workman grow large. The lens becomes rounder, concentrates the light too much, and the person becomes near-sighted and uses glasses to correct the defect.

Thus in each eye of man, and animal of the higher species, a living lens grows according to every law of light. Do we stop to think what learning and art are required to make a lens. Alvan Clark of Cambridge, Massachusetts, spent four years grinding the great glass of a telescope. He rejected 30 glasses because of flaws and waves in the materials. Go to a factory where optical instruments are made, see how they work according to mathematics and the laws of light and you will be astonished. Yet day by day come into the world men and animals, each with two eyes with lenses alive, formed of blood, made according to every law of mechanics and of optics. Yet no one thinks of that Mechanic, that Optician, that Chemist, that Artist, that Workman, that Mind infinite, who makes the human soul and living principles which build these eyes as lenses, microscopes, telescopes and astounding optical instruments, because they are so common.

Look inside the tube of telescope, microscope or optical instrument, and you will see the whole interior covered with black to absorb the rays of light, which would be reflected and confuse the image. Look inside the eye and you will see its interior covered with an intensely black pigment placed there for the same reason. Only the light passing in straight rays through the lens, there-

fore, falls on the retina and there paints images. Did not the One who makes eyes know this must be done to see clear, bright images?

The eye is the only instrument which can be used as a telescope to see at a distance, and as a microscope to see small objects near-by. The lenses of our instruments are of hard glass, while the lens of the eye is formed of living tissues more or less soft. That its shape may be changed it is provided with muscles which instinctively change its form when we see far or near, while other muscles accommodate it to the rays of light coming into the eye from a near-by object, or at different angles.

By accident it was discovered that light passing through a glass ground as a lens is bent out of its straight course, and telescopes, microscopes and all kinds of optical instruments were invented. But if men had understood the eye better, they could have made these instruments ages ago. To make the lens of an instrument the maker must know the laws of light. But here is an optical instrument a thousand times more perfect than any man makes. Different animals have eyes of varied construction.

Who made these eyes according to the laws of light? When we study the eye and compare it with optical instruments man makes, we are forced to the conclusion that a Mind infinitely wise in the laws of light built most wonderful instruments. To think that from red blood flowing into the eye before birth all these members are constructed, some as transparent as a diamond of the clearest water, and far superior to any telescope, is surprising. If we take the human eye alone, leaving out the thousands of different eyes of animals, each species having an eye built best for its purpose during life, we would be forced to say an optician of infinite wisdom made this eye. Ages before we understood what light is, its nature or its laws, men had eyes built according to these laws. The eye lens alone would

prove the existence of an infinite Creator if we had no other proof.

Behind the lens of the eye, the whole interior is filled with a clear crystal water, through which the light passes now bent out of its course to fall on the retina behind. The retina, "a net," covers the interior of the eye behind. It is a delicate nervous membrane, a continuation of the optic nerve branching from the brain to each eye. On its surface the images of objects are formed. With a round concave looking-glass with a hole in the middle, we light up the interior of the eye and through the hole see the retina. It is of a pinkish yellow, with a bright yellow spot almost in the center. Near one side comes out an artery which branches out like the limbs of a leafless tree, and supplies blood to the retina.

The retina lays on the choroid lining, covering 5/6 of the back part of the eye, having in front the crystal water filling the organ within. The retina is soft, more or less clear and transparent, having in the center, exactly opposite the pupil, a round elevated yellow spot in which vision is the most perfect, but found only in man, fourfooted beasts and some reptiles. About 1/10 inch from this spot, towards the nose, the optic nerve comes through and spreads over the retina, this is the only spot in the retina not having the power of seeing.

With the retina we see; all the other parts of the eye are to bring in the rays of light, and spread them out over its surface. It is a most wonderful construction. Examined in sections, cut carefully down perpendicularly to its surface, it is found formed of 10 layers from within out as follows: 1, a covering or lining membrane separating and uniting it with the interior covering of the eye; 2, a fibrous layer of nerve cells; 3, hollow vessels composed of layers of nerve cells; 4, layers like minute grains; 5, layers having kernels; 6, granular layers; 7, another layer of grains with kernels; 8, a membrane inclosing them; 9, a layer formed of

rods and cones rising like a thickly sown field of grain, each pointing outwards; 10, a layer of tissues, which we see as the yellowish colored retina when we look into the eye.

The inner lining, No. 1, is derived from the supporting framework of the retina. The fibrous layer, No. 2, is made of the fibers of the optic nerve grouped in bundles, which passes through the layers of the retina, radiating to all parts of the structure. The vessels of No. 3 are hollow-flask-shaped, their rounded inside mouths resting on the preceding layer, and sending out, each a single process, as a continuation of the nerve, into the fibrous layer outside of No. 4, where they divide into two pairs—thousands of them cross and recross like the cords of a net, then pass into and unite with layers No. 5 and 6.

The layer No. 4, called also the inner molecular layer, looking like a field of microscopic grains, is a dense net of little fibers intermingled with the fine vessels of layer No. 3 with which it is believed they communicate, between the meshes of the net-like structure are minute clear granules like microscopic grains, the nature of which is unknown up to the present writing.

The layers of No. 5 formed of minute kernels, are composed of three different formations: a large oval body in which two nerve fibers pass outwards and continue through the granular layer in which they branch, and then unite with the same branches from the two branches on either fiber. In the microscope they look like minute beads hung in bunches on strings, three in a bunch, one a little higher than the other—they hang in protoplasm filling the layer. These nerve fibers continue out through the different layers of the retina till they end in the rods and cones.

The minute nerves of sight now pass through a thin layer of dense fibers, branch from one to another, forming a fine network, the spaces between them being filled with microscopic ganglionic-cells. They unite still

farther out again, into nerve-fibers, and expand into the rods and cones, which extend through the outer layers like hairs on the coat of an animal. The rods are more numerous than the cones and are at different levels. They are cross-striped, each ending in a single rod. The enlarged ends give out minute fibrils. The cones, less in number, not striped, are longer than the rods, come out farther towards the middle of the eye, and end in long round enlargements. From their ends branch many small fibrils which enter the colored layer covering the retina and which we see when looking into the living eye. All these parts of the retina can be seen only with the best microscope only after death. We cannot see the workings of these different layers of the retina in the act of seeing, because we must cut these layers apart to examine each one and that destroys the sight.

Here is an organ with which we see appearances of material things, through which the surrounding world enters into relation with us, through which material images or forms of surrounding objects act on the unseen soul. Eye, highest of the senses, is a window through which the spirit in man sees the material objects through the images they imprint on the retina. The material cannot act on the spiritual except through the five senses.

Let us see some details of the eye, that wondrous sense of sight. Retinas of animals are of diverse tints. In the dark they are one color, which changes in light, and each eye and retina are made according to their mode of life. In the dark a cat's retina flashes a beautiful pinkish yellow which vanishes in the light, the human retina is a bright yellow, many times we examined it with the instrument, but we cannot see the images painted on its surface.

The eye is a dark chamber like a photographic camera, the latter is dead, while eye lives; camera takes a picture in a fraction of a second but eye is more rapid, it takes

a photo in dark colors, while eye takes in colors of the object, focus must be right or the image will be dim, but the eye adjusts the focus for near or far objects, the picture remains while that in the eye stays only while we look, and vanishes in an instant. We use diaphragms with different sized holes, but the eye has a curtain, the iris, which accommodates itself to the amount of light wanted. The eye uses without our knowledge every law of optical instrument, devices we do not know, and is a thousand times more perfect than the camera.

Light falling on objects divides—some rays are absorbed, other rays of different colors are reflected to the eye, the object is colored according to the colored rays thrown back. These light rays pass through the clear cornea or pupil of the eye, which bends them together, through the lens which bends them more, both when entering and leaving, fall on the retina behind where they gather in a bundle and paint pictures of objects in their natural colors. We cannot see what takes place in the 10 layers forming the human retina, to take them out and put them under the microscope would destroy sight, but we have partly succeeded with animal eyes.

Vibrations of air cause sound, vocal organs enable us to talk, we feel beats of great organ pipes, music's varied tones and harmonic beauties, but vibrations of ether trembling 450 millions of millions of beats a second cause red light, beating faster up to 750 millions of millions a second cause orange, yellow, green, blue, purple and violet tints, which united make white light, spectroscope separates into these colors.

What must be soul power of seeing, which builds an organ to perceive waves of luminous ether waving with this enormous rapidity, that sees stars with light which left them 1,800 years ago, that with these waves paints images of objects on the retina, that forms a landscape in its natural colors, that blots it out in an instant and forms another the next moment, that not once but all

our lives these paintings come and go with the rapidity of lightning.

What time and care artists spend carving images, painting pictures only in their outlines, so crude when closely seen. Who is this Artist-Painter, this Photographer in colors, who made this astounding instrument in man and beast, who made not one but countless millions of eyes, who made not directly eyes, but the living powers which build them? With a blindness astonishing we say Nature, a pagan name for God with wisdom infinite.

We have given the eye as a mechanical instrument, but it is more, for within it astounding chemical changes go on. For its 10 wonderful layers of the retina, its networks and rods and cones and microscopic constructions the light sets moving, trembling and waving from 450 to over 750 millions of millions of beats a second. Protoplasm, foundations of living organisms in life processes form ferments, chemical changes in the retina, unions and disunions are built and torn asunder without themselves being affected as described by Waller and Allichin in their studies of animal eyes.

Their experiments show the 10 layers of the retina, under the influence of light, give out colored ferments, corresponding to the colors of the object, proteids, peptones, chemical changes, unions and divisions, which special rods and cones take up, comprise these colors, the ferments change by light action and act on the different layers of the retina. Thus microscopic rods, cones, nets and organs wave with swiftness of lightning and form images colored exactly like the object, and the nerves ending in the retina convey the impressions of sight to the brain.

What therefore must be the spirit of man which builds such an organ as the eye? How wonderful are the living principles of beasts of untold and uncounted species, which make their eyes! But what will we say of God who created the life principles which construct

such instruments according to laws of light, mechanics, chemistry, optics and every science? The human eye alone, carefully studied as an optical instrument, would prove God. But what will we say of insect eyes with hundreds of lenses, of fish eyes made to see in water, or of the countless species of beasts, each with eyes accommodated to their lives!

We marvel at great telescope weighing tons, costing half a million, we look with wonder at our microscopes revealing a world beyond our sight, we hold in honor men who invented and improved the spectroscope, we hand down in history those who searched out the mysteries of matter changing in chemistry, we are interested in optical instruments, we glory in the progress of science in our age, but we seldom think that in our head are two living instruments, which grew without our knowledge, which unite all the principles of these instruments and live the life of the spirit within us!

Eye of man and beast is at the same time a telescope, microscope, spectroscope, chemical laboratory, photographic camera, sculptor of images, painter of pictures in natural colors, an artist painting pictures which live for a moment and then vanish, a civil engineer which measures distances without instruments, an engraver in lines—all arts of mankind combined could not bring forth such perfect forms as the images in your eye through which you see. Where is the man who will or can say no Supreme-Scientific-Artist made man and beast with such surprising organs as eyes?

CHAPTER XXIV.—WHAT IS THE HUMAN SOUL? WHAT IS REASON?

THREE centuries and a half ago, in the name of religion began unbelief, in the name of liberty free thought, in the name of history slander, in the name of science a false knowledge of nature, and since these principles have been poisoning the mind of mankind.

To-day small-brained, half-educated professors sit in schools, colleges, universities, teaching free thought with boundless licence to thousands of untrained, easily impressed students, who drink as Gospel truths half-baked, ill-digested, dangerous, destructive, infidel opinions they take into the world as guiding principles of their lives. Little is the show of common sense, or depth, or learning, or logic these pin-headed teachers and students, leading society, show us in their surface scratchings.

The sweep of the spirits of darkness is now over the world misleading the innocent, the upright, the woman, the child, the people. In France infidel floods stopped not till the land was red with blood of her noblest sons and fairest daughters, and it looks as though the nations were plunging into anarchy, the human race into utter ruin.

After graduation, boy philosophers, rotten before ripe, youths leaving school with a smattering of learning, who skimmed the surface, newspaper educated, strut in mannish pride flinging flippant free-thought, infidel principles, while the mob mocks the creeds that held the world in balance for 2,000 years and civilized the nations. Protestant preachers see their con-

gregations each year getting smaller while the earth reeks with infidelity.

A thousand fools prate about science who never tasted the deep springs of knowledge, who could not point out Sirius from Arcturus; who could not say how many bones and muscles are in their bodies, who could not tell us why it rains; who could not give even the names of the grasses under their feet. They flit from one subject to another, seem educated to the crowd, while denying the existence of soul, the future life, and even God Himself. Pride in the mind, weakness in the will, darkness in the intellect make them try to imitate the Newtons, Thompsons, Aquinases, Aristotles and the Platos, who penetrated deep in nature, who enlightened the world with their learning, whose studies led them into the beautiful light, where reason and revelation, upheld by natural religion, clasp hands over the beautiful figure of faith in God and in the life beyond.

This spirit of doubt rising from the abyss with a shallow probe inspires to only scratch the surface and is blind to the wonders of the universe. Darkened by sin, possessed of this spirit, "small men", ignorant and prejudiced, draw near eternal truths of God and nature with hate and defiance, looking for a law to salve their sins and free their lusts. Brutalized by passion, physical liberty becomes the mob to burn and kill, free thought spreads till wild isms rise to strike down our noble presidents, assassinate rulers, rob the rich, endanger society, and would if they could drive the nations into anarchy.

For 2,000 years the heathens raged against the Rock of Ages, saying she was weakening and would die; but she will live to see the death of every error. Herod killed her innocents, Pilate crucified her Founder, Rome martyred her millions, Voltaire and Paine drenched her with infidel ink, they pointed scorn and sarcasm at her but every attack fell harmless from the armory of eternal truth with which the God-Man has

clothed her. Infidel hosts shouting science assail her, yet from each attack she comes forth beaming with the brilliancy of the animating Spirit in her.

Though modern schoolboy scholars smite her granite sides, though spades of ignoramuses have dug at her foundations, though falsehood shafts have tried to pierce her adamantine walls, though thousand cymbals of unbelievers beat the air, though million mocking sophistries assail her teachings, still she stands, Bride of Him her Founder, blessing and uplifting the nations. From the day the Son of God, Jehovah Elohim, who became man, called to our father: "Adam, where art thou?" she triumphed ever over error and will till the end of days.

Plato and Aristotle, the great of Greece and Rome, Augustine and the Fathers, Aquinas and the Schoolmen, the most learned of our race mapped out in most minute details the nature and acts of mind and free will, filled libraries with their works, written in languages little minds of our day cannot read. Hence the latter know almost nothing of the human soul, its twelve powers. Starting from matter seen by the senses, following false principles, under the name of learning and science they flood the world with misleading works.

Let us give a rapid glance at man's mind and free will, regretting much to our sorrow space will not allow us to treat fully these angelic powers of the human soul. We will not give wild theories found in so many modern works under the name of philosophy "knowledge of the soul", but what everyday experience tells us, and in the simplest English words.

Every one having the use of reason during waking hours thinks, talks to himself, brings forth thoughts, ideas. It seems as though another person were within us, with whom we in silence speak. We compare thoughts, reason out our ideas and actions before we bring them forth into words and deeds. What is this power within us? the human mind or intellect.

Every person feels he is free to do, or not to do, to choose the good or bad, to do an honest or dishonest action, to sin or not, to resist temptation or to yield to it, to give way to his passions, or to smother and control them, to rise to the highest virtues or to sink to lowest sensuality. What is this power of the human soul which rules the whole man? The free will, the seat of liberty for which millions died in battle to uphold.

These two soul powers, reason and free will, working together form mind, the noblest power of mankind. All other powers of the soul, the human body, the whole man, are like the foundations on which mind rests. When we do not know why a person does a thing or acts in a way mysterious to us, we ask "What are your reasons?" Every human being has a reason for his acts; if he cannot reason he acts like a beast, follows his passions and instincts like people in asylums wherein the totally insane are guarded. The greatest calamity which could fall on a human being is to lose his reason.

The ancients called man a "reasoning animal," science shows they were right. No animal can reason, grasp truth universal. We think before we speak, words express our thoughts. What are these thoughts? how does a man learn to use his mind and think rightly? At school the teacher shows the child the letters of the alphabet, saying that is pronounced A, that B, etc. Soon the child learns that figure is called A, that B, etc., wherever found. He finds letters grouped together as D O G represent his dog, in a few weeks he understands groups of letters making words mean names and things. He passes into the first primer, later he reads simple stories, advances into higher readers, begins arithmetic, goes through the common branches up into the high school, goes through college, then graduates at a university, and thus becomes a learned man.

Take your dog, horse, or an ape, show him these

letters, teach him to read, tell him these letters and words are images of thoughts, signs of things. You may spend your whole life but you will never give a beast the slightest hint of what these signs mean. Animals have not therefore the power of the child, they have no mind or any power above the imagination, which sees only the material images. When animals can be taught to read, we will believe evolution true.

No beast can be taught to read, speak or think like the child. They learn their names, a few tricks, are trained to work, etc., that is all, while the child may become as learned as Newton or Augustine. Without an exception every member of our race can, if in his right mind, become educated, but no animal can.

It is certain, therefore, man has a power or faculty no beast has. We call that the mind, from the Sanscrit "to measure," for mind measures or grasps the universe, intellect from the Latin intus legere, "to read within," mind is the understanding, the eye of the soul, light of man, etc., etc. Every language ever spoken has a name for mind, for all men know they have this power, which distinguishes them from beasts, and they know by instinct and experience no animal has a mind.

How does the mind work? As you run your eyes along these pages, thoughts or ideas rise in your mind exactly like the ideas in the writer's mind. Instantly thoughts flash forth in your mind so you can read perhaps a book of hundreds of pages, skim rapidly over the newspaper to see the world's history of a day, get absorbed in a fascinating story, or listen to the spoken words of those you love, or of friends you meet. To think, to bring forth thoughts, is man's highest power, purest joy, for it is the function of his angelic faculty. To be deprived of it, to shut a person in solitary confinement with nothing to read or do would drive him to insanity.

When you read, or listen to a conversation, you pay no attention to the words, you think only of thoughts

or ideas. But if letters or words be misplaced, then only you see them, while if the words and sentences are all right you will not notice them. Why is this? The object of the mind is truth, but there are two kinds of truths—particular, or single truth, and universal or general truths. What is truth? That which is. Whatever exists is true, what is not is false. Each object, each material thing in the universe is one single truth, for it exists. Your senses, being partly material and partly spiritual, because senses are organs animated by soul powers—the five senses see only one singular object. Ears hear spoken and eye sees written or printed words through particular images. They send these images of objects in to the interior common sense, a receptacle of the soul, where they are compared, they are then handed to the imagination, which brings forth images of material things perceived by the senses. The mind grasps them and makes them universal or general thoughts or ideas.

This process is as rapid as lightning. Senses, common interior sense, and imagination use the brain and nervous system during this process, these nerves and brain, partly material and partly spiritual, being vivified by soul powers, they tire after long use. For this reason you cannot talk, read, or think all the time, you must have a change. When tired or sick, when nerves are injured, when brain is hurt or diseased, images are with difficulty offered the mind. When nervous system rests in sleep you do not think. When imagination works you dream. When nerves are greatly injured you are insensible, in a state of coma—senseless.

The mind does not use any material organ in thinking except as given above, for it is purely spiritual. How false then it is to say such a man is "brainy," as though the brain, a simple emulsion of fats, etc., thinks, as though purely spiritual thoughts could be produced from matter. For the universal cannot come from the single material objects in nature.

What are these general or universal truths, the direct object of the mind? Letters in books, newspapers, etc., are signs which give rise to the same ideas in the mind of every one who sees them when he knows how to read. Spoken words of any language, have meanings, are signs of thoughts. When you hear or read these words, the thoughts or ideas these words represent rise instantly in your mind. Each sentence composed of words and letters represent a universal thought or idea. Look at this white paper and think of all white things which now or ever existed, and you have the universal thought of all whiteness that ever was or will be in the world. Every figure of arithmetic, of mathematics, is a universal truth, for you can apply figures to an infinite number of things.

Universal truths are therefore boundless, infinite in extent, relate in past, present and future to all properties of matter. Thus from the one individual thing, mind grasps the universal thought. What a difference there is between the one object of the senses and mathematical truths, changeless and eternal. Yet to this height human soul extends above the animal, there is no half way. The moment the child makes an act of reason, it sees being in general, the universal, boundless in extent. How could such a power as mind gradually develop from an animal with only senses and imagination acting in and amid particular single objects and images? Mind grasps first universal truths during this life, images of that real eternal Universal we call God, whom it will grasp, seize, as infinite Truth after death.

Material things in nature are objects seen by the five senses which are like windows through which the soul receives knowledge of natural material truths. The object of the mind therefore is spiritual truth, which is of two kinds—particular truths and universal truths. The first or direct thing mind seizes is universal truth, the secondary object of the mind is particular truth. Hearing a person talking, or while reading, you grasp

the meanings of the speaker or what the writer says, because words spoken or written cause his thoughts to rise in your mind. If you don't understand him you say "What?" if letters or words are broken or misplaced, you stop and examine the letters. First mind grasps the universal ideas or thoughts in the words, that is, universal ideas, but must stop to see particular ideas. Thus you grasp universal truths first, and later particular truths.

The particular truth is any single, individual thing in nature perceived by the senses, an image in the imagination, or one truth in the mind. Touching, tasting, smelling, hearing and seeing gives us a knowledge of material things here, now before us. The senses are organs of the body formed of matter, being animated with the soul's powers giving them its life, they cannot therefore rise above the material of which they are made. The senses see only material things of the universe, beyond, into the spirit realms they cannot perceive; thus far and no farther, the five senses of man and animal penetrate. Through these five senses man gets a knowledge of the single, individual objects in nature, which act on our senses, which must be present, here and now to make impressions.

How does the mind arrive at truth? You see a tree, and instantly think of every tree, of trees in general; you see a man and think of every man, of mankind in general. The next instant you think of this tree, of this particular man. So it is with all things seen by the senses: first in the mind rises universal truth, then particular truth. If the acts of the mind were reversed, so you saw single, particular truth, first, you could not learn to speak or read, and be little higher than an animal. But because you grasp universal thoughts first, you read rapidly without thinking of the letters and words representing the writer's thoughts.

Aristotle first explored the movements of the mind he calls the syllogism "to think with." The most

simple syllogism is formed of three propositions or sentences, the two first being named the premises, and the last the conclusion. The first proposition the mind lays down is a universal thought, the second is a particular thought. We compare one proposition with the other and draw from them a conclusion. For example: Man is a reasoning being. John is a man. Therefore John is a reasoning being. To take what does not belong to me is stealing. This watch belongs to another man. Therefore to take this watch is stealing. To kill a person is murder. That moving object is a person not a bear, therefore to shoot him is murder. But you may say to yourself, that is surely a bear. You shoot and kill a man ; that is not murder but an error of judgment.

In thinking we bring forth, nearly all the time, universal thoughts, compare other universal or particular or single thoughts with them and draw conclusions. We pass from the known to unknown, or less known, in this way we learn. The laws of God written in our reason, the laws of the country where we live, the revealed laws of God are to us universal thoughts: our acts are single particular truths, which we compare with the universal laws, which if we break is sin. You say I cannot do that because it is against the law. The mind in this way guiding man is called conscience, to act against this private monitor ever within and directing us, is sinful. To subdue our passions—the beast within us, and get in the habit of controlling them is virtue. To always give way to them is to acquire vices.

We said the first and direct object of the mind is universal truth. The mind has the power of grasping all truths brought before it, but we never learn all we would like to know. The love of truth is never satisfied in this world. There must be another life where this desire is satisfied, there must be some Universal Truth which will fill the human mind, or nature has given us a wish, a longing, never to find its object,

never to be satisfied. The very nature of man's mind, then, demands another life, the real Universal, of which universals in us are images. Who is that but God whose existence naturally follows from the conduct of the mind?

We will not go over the description Aristotle gives, which all ages since his day admit, regarding the different ways the mind acts, and the laws of syllogisms. We express our thoughts by words. Names stand for persons, places, things; verbs show their actions; adjectives show qualities, adverbs show the qualities of verbs, pronouns stand for nouns and little words make up the minor parts of speech—under, behind all being the verb to be, expressing the very existence of all beings, or truths which are or can be.

Round names cluster other thoughts relating to what they represent. When you hear or read these names, other thoughts, children of your mind, rise. One thought gives rise to one or more thoughts connected with the chief thought roused by the name of the person, place, or thing. You hear Jerusalem, "Jehovah will give peace," and you think of Jesus, "Jehovah saves," the One foretold to give peace to mankind. You think of the great Temple like a vast slaughter-house where for 1,100 years every ceremony pointed to that place outside the walls where He died, with the mocking multitude sitting on the slopes of the hills like a great amphitheatre with Calvary as its stage. The word Washington brings up in your mind that great and good man, who gained for us our liberties, and was the chief personage in founding the greatest nation to be, from which the world learns liberty, progress, invention and prosperity. Lincoln recalls the horrors of the war between the States, the freeing of the slaves. New York, built on the greatest harbor, was pushed ahead by the canal running through a rift in the Alleghanies through which the commerce of the West reaches tidewater, and you say here is the foundation of the greatest city mankind ever built. So from

one thought rise others, this we call the association of ideas.

We find pleasure in the exercise of our organs, in the activity of our members, these are soon satiated, but the mind never. Mind itself, bringing forth universal and particular truths, never tires, never wearies seizing truth, for it will rest at last in the eternal Truth of God the Son, Truth of the Deity whose truth we see but dimly now in nature.

Man acting as a reasonable being, acts from a motive, there is a reason he does things, he acts according to the light he has. When we do not understand his motive we say "I cannot see why he acted so." The pleasures of thinking, of reading, of talking with others are the purest, highest joys of life. Thus between man and man are chats, conversation, business, contracts.

If ignoramuses, half educated scientists, little-minded infidels, had studied the conduct of the mind, had risen above what the senses see, had even thought a little on their own mind, how the child learns to read, spell, cipher, and gets an education, they would not have fallen into evolution, spent years of fruitless search after the "missing link" between man and monkey, or filled libraries with half-baked scientific publications.

Take any truth, or thought, you cannot divide it, cannot change it ; it has no parts—no length, breadth, thickness, weight or material quality. The mind seizes truth universal relating to and extending to all things, like mathematics. This mind, has no shape, form, size or material quality, must live as long as these truths it seizes will last. Things cease to be by decay, change—part separating from part. But the mind, having no parts to dissolve, cannot be destroyed. The soul is as deathless as the truths it brings forth. There is no way of getting away from this reasoning.

While beasts live in the present, knowing nothing of the future, with memories embracing a few incidents

of their lives, the human soul sees past, present, future, grasps the infinite, eternal truths of law, literature, thoughts of millions of writers who have passed away, it too must live as long as the truths it brings forth, for you cannot put a barrel of water in a quart measure. Soul could not see the universal, unchanging, immortal, truths of mathematics, virtues, etc., unless it also were immortal.

Man with mind grasps all truths presented to him, weighs and maps out millions of suns, figures out their movements, foretells eclipses of sun and moons to the second, advances with giant strides to conquer nature, —will you say he will not last longer than orbs of sky, longer than nature he has subdued, longer than giant tree living thousands of years, longer than mount and plain he pierced and planted? Such a thought is absurd.

Some truths are so clear they want no proof. Axioms of mathematics and self-evident truths appeal to us so clearly no proofs can make them plainer,—the whole is larger than any of its parts, the mutiplication table are to us true, require no arguments to show their truth. So in human lives are truths as certain. One of these is the thought we will live after death, that beyond the grave is another life. All men of every place, nation, tribe and tongue, of every age, believed this. Hence human bodies are not thrown aside as those of beasts, but laid away to rest with funeral ceremonies. All men are by nature religious, no people, no matter how low and degraded, ever lived without religion. Man's deepest instincts move him to worship something in hope of rewards after death. If there be no future life, man's nature has deceived him, his whole life and all his thoughts regarding life after death are delusion. If God has deceived us in this, the most important sentiment of human life, if death ends all, human reason, human life, all we hold most dear are dreams.

Men are good or bad according to their lives. Some are innocent, others wicked; men are honest and men are cheats, and some are murderers; all laws of human

society cannot punish all the wicked, make some men upright and honest. Prisons are filled with criminals while many murderers escape capture or conviction. If there be no future life, if death is the end of man, the good cannot be rewarded, the bad punished, the world would be filled with injustice, for rewards and punishments cannot be meted out according to justice, and justice would cease. Those who escape the punishments of this life, and those who live honestly would receive the same rewards. Another life is required therefore to right wrongs, and reward virtues. Can we suppose God would leave things this way? Has He not the justice at least of men? Has He not every perfection, all perfections in creatures are in Him, and He must be infinitely just. A thousand reasons might be given to prove life beyond the grave but we have not space.

Every one knows he is free to act, to walk, to talk, to come, to go, to control his passions, to practise virtue, to do as he pleases. Some men have been so unwise as to deny man's freedom, but no one listens to them. There is in us a power which controls our acts, not all of them, but the reasonable faculties of man. Plant functions, foundations of life, are beyond our control. Our animal functions are more or less under our control. This power within us is called the free will. No power on earth can manage it, even God himself respects it, for it belongs to the human soul. It is the seat of human freedom. A man's physical freedom may be taken away, he may be imprisoned, but his will may remain stubborn, for no human power can control his interior acts of reason.

In some of his acts man is like an animal, but when he acts as a reasoning man his acts are called human—the acts of a reasoning being. For such acts he is responsible, for then he acts because of a motive, a reason he has in his mind. He can do good or bad, act in a good or in a bad way. Acts are good, bad or indifferent. He is capable of highest virtue or of lowest

degradation, can practise the highest virtues or commit the greatest crimes.

What is the will? As Augustine says, "every act of the will is to seek happiness." The will is blind as all powers of the body are blind. A man is enlightened by his sight, so the will is enlightened by the mind. Man acts and moves directed by his sight, so he acts for an end as the mind points it out to him. Reason and will in acting form mind; these two powers are man's rational faculties. Everything a man does is for his pleasure—his happiness. No one seeks pain, misery, wretchedness for themselves; his final object or goal is pleasure. If he willingly suffers pain, it is that he may arrive at last at ease and pleasure. The object of the eye is what appears to the sight, the object of reason is truth, the object of the will is the good, the possession of the good is happiness. To be deceived by the eye is a misfortune, to be deceived in the reason is error, to be deceived in the will or do wrong, is wickedness.

Nothing in this world will satisfy the will. All the pleasures of life, all the wealth man can accumulate, all the world, if he could gain it, will not fill or satisfy man's everlasting wish for pleasure, for something higher, better. This is the deepest instinct of our nature. What is this overpowering desire in us for joy, pleasure and happiness never satiated in this life? Has nature deceived us in giving us a longing for what we never find here? This joy which will fill and complete our natural desire of pleasure is the last, full, measureless good, which will fill the created will, not in this life, but in the other. Who can this be but God?

The object of the mind is truth. What is education but the grasp of truth? Who ever exhausted learning? Who lived who could not learn something more even in his last hour? As mind can never be filled with all learning in this life, there must be some truth beyond and after this life, which will fill up the never-satisfied

longing for more knowledge. Who is that but God, for where is all learning to be found but in Him? From the very nature of reason, from the acts of human reason and free will, flow proofs of God's existence, or man's very reason is a delusion, a mockery, a living deception, and a series of lies.

Truth eternal, infinite, everlasting, ever filling mind of creature is the Wisdom, the Learning, the Knowledge, the Logos, the Word of God in whom angel intelligence and mind of men after death find all education, all truth, all knowledge their minds desire or long for in this life, where truths they see while living here are but images of the divine Son, mind will see after death.

Good, eternal, infinite, everlasting, ever filling will of created mind is the Goodness, the Happiness, the Joy, the pleasure unthinkable of God, in whom angel will and will of man after death find all pleasure, happiness, joy they desired and longed for and looked for in this life; all pleasures they find in this world are but images weak and feeble of the Holy Spirit in whom human will rests after death.

To seek truth, to find pleasure, is the very nature of our reason: to be deceived, to suffer is against our nature. We cannot love a lie, a deception for itself, we cannot enjoy sufferings, pains for themselves. Therefore we are not free regarding infinite Truth and happiness. The last end of human souls is truth and happiness, not error and misery. But this world is filled with both. There must be another life where these two boundless longings, welling up from the very nature of our reason, will be filled and satisfied; there must be something to fill up these two boundless aspirations of our reason. That something must be boundless, measureless, to satisfy, fill up, these two—mind and will, the aspirations and desires of the countless men who lived and died. What can that be but God himself? There is no getting away from this reasoning. Reason will rest in God the Son, the Wisdom of the Father;

Will will be filled with the Holy Spirit, the Good and the Love of Father and of Son.

We are not free therefore regarding truth, not free regarding happiness. But we have freedom regarding different means of getting them. Some seek truth in one way, others in another way. Some find their happiness and joy in one thing, others in different ways. Each is free to select the means. Thus, men differ, life has all kinds of trades, occupations, Providence gives different vocations. Many are rich, but more are poor. Active must be the one who is happy. How wretched is the one who has nothing to do, no object in life? The happiest is the one who has work, not too hard, from which he gets enough to live. Often the most unhappy are the rich with nothing to do.

Man was made a temple in whom God dwelled, no temple ever made by man equals in beauty and perfection the human body and soul—a living, beauteous structure, animated by a deathless soul, built for the Almighty in which to dwell in closest union. Man sinned and drove out the Eternal by a wicked act of his will, for God cannot reside with sin—a disorder in nature. Freely and with deliberation was that sin committed. Man can generate only according to his race and every child is born of fallen race of his first parents, is a member of a fallen nature. Every child must be restored to the form of the original man God made, become again a temple of the Deity like Adam in his innocence. Then God in the soul gives faith, a light of the soul is given him which no human being can get no matter what he does. All the learning, all the virtues he may practise, all the good he may do are natural, and will not give him that eye of the soul, by which without an effort he looks beyond the veil of nature into the wonders of the realms of spirits. The child, the ignorant, the lowest may have faith, while the most learned, the greatest of earth, may be without it—without God in the mind and will.

In our story of the universe, we saw the awful, unthinkable might, wisdom and power of the Eternal ; we but faintly know what it is to break His laws, to freely and deliberately sin against Him. Each of us bears the marks of an ancient upheaval, a wound in our very nature. There is a continual conflict between our animal passions and our reason, beginning as soon as the child gets the light of reason, and lasting till death It is easier to do bad than good. What is that but the remains of a fall? All nature works in harmony, according to the designs of the Creator.

Man alone is an exception, he alone in this world has freedom to do right or wrong. How did this come? Revelation, the traditions of all nations tell us mankind fell from a state of innocence. Our first father and mother, acting for us, representing us, as our President represents us signing a law, sinned, rose up against God, drove God out of their nature, and since every human being is born in that fallen state, for man must generate his race as it is and it is fallen. Before this, angels, with full knowledge and free deliberation, sinned and fell, there is no way to redeem them, they would rather suffer than serve, they hate their Creator and live forever fixed in stubbornness—totally depraved.

But man was deceived, more sinned against than sinning; he is not totally depraved, but his nature is injured—that is, he is born deprived of the indwelling of God as in a temple filling and completing all within, making all powers and passions subject to reason and free will. Man is born without God within him, and every power and faculty bears signs of that great wound.

Man is injured in his mind. For how otherwise explain the mind so darkened. We spend our lives thinking of worldly things, hardly ever raising our thoughts to God, who alone is worthy of our study. What is the universe compared to Him who made it? What an effort it is to rise to his wonders! As the first object

of our minds is universal truths, so the first thought should be of Him, the real, eternal Universal, of whom the universal in our mind is a weak image.

We are injured in our will. For the whole wish of man is wealth, money-getting, pleasures of the senses, whereas if we were upright, as God made our race in the beginning, we would be always seeking God the Good, the Holy Spirit who alone can satisfy our longings for the good, the possession of which gives real happiness. All our days we are worldly in all our ways. Even on our deathbed, our thoughts are of things of this life. Is not this a mark of a fall from a higher state?

A good person who received God as we described, who lives a good life, in him God dwells as in a temple not built by hands. He avoids sin or gets sins removed and then again he is in union with his Creator. All his life, he loves God, God loves him, for God is love and love is union. During his life his soul is united with the Eternal. He is about to die, his soul passes away beyond the veil. In life he was united with God, when his soul passes away that union continues, for he did nothing to break the nuptials of his soul with God. His mind rests in union with God the Son, the Universal Eternal, the Word and Wisdom of the Father. He spends eternity in learning new truths from the eternal Learning of God. He passes from one truth to another according to what he merited while living. His will while living was united with the Good of God, the Holy Spirit, the possession of the good causes happiness, and according to his merits he will be filled with the happiness of the Holy Spirit. That soul is in heaven, which is not a place but a state of union with God.

When a person dies, his body and all its organs die, the world vanishes, he sees no more material things. His mind and will alone live, for they are the deathless powers of the soul. Heaven is the union of these two powers with God in this life, reason and will, forever seek Him even with their natural instincts. In heaven

therefore there is nothing material, neither past nor future, but the ever-present of God. Man then is in the state we call eternity, without beginning or end. There the soul begins its true life, of which this life is not even like to the tick of a clock compared to it in length.

Suppose the person sins, he drives out God from his soul. He lives amid the joys and pleasures of this life, where the order and regularity of nature reign. He dies. He had not God united to his soul, and when he passes away he has not God whom the very nature of his reason in its very foundation demands. He has not truth or happiness to satisfy the longings of his very reason. He seeks truth and finds error, harmony and finds discord, beauty and sees deformity. The truths of science, of nature for him have passed forever. His mind has nothing on which to dwell, he cannot reason rightly, his state is indescribable. He looks for love and finds hate, his will seeks the light of the mind and finds spiritual darkness, rest and there is no rest, happiness and all is misery, all his will wants by its very nature is wanting. You cannot imagine the state of that soul away from the God it was made to rest in. You cannot describe the sorrow of a soul made for God, its last end, and deprived forever of His sight and of His love.

Mental sorrow is more acute, more piercing than any bodily pain, because the spiritual is more perfect than the material. Think of the sorrow caused by the loss of wife, husband, children or friends, magnify that millions and billions and you will not realize what the sorrow of the soul is for having lost God in eternity, for which the soul was created. Then you may have a faint idea of the awful indescribable sorrows caused by the knowledge the soul has, knowing it lost God forever and forever, for which the human soul was made. This is the pain of hell. The sufferings then of hell no human being can conceive their intensity, how great they are. They will last forever, for hate

reigns every moment, the soul hates God whom it blames for such sufferings, which are in proportion to the sins the person committed—that is, one who stole $10,000 will be punished ten times as much as the one who took $1,000.

Sin is a rebellion, an uprising against God, an infinite Being, and justice requires an infinite punishment. But the soul, being a finite being, cannot bear infinite pains—that is, sufferings infinite in intensity. Eternal justice requires that the sufferings be infinite in some way, and therefore the pains are infinite in length—that is, have no end. Out of hell there is no redemption. There is no merit or reward there. It is God's everlasting penitentiary, where souls are condemned for great crimes while the wicked exist, as men are sentenced to prison for life.

But you ask is it not awful for God to condemn souls to everlasting punishment? God never sent a soul or demon to hell. They knowingly and willingly send themselves there when they commit the sins.

Will death end all for man? Will his aspirations for endless, infinite life, truth and love be never satisfied? Our very reason wants, demands, a life lasting ever and forever.

Reason whispers to the soul
  Of a life that is to be,
As travelers hear the billows roll
  Before they see the sea.

In this world our life begins,
  That will last forever.
Here our merits heaven wins,
  Will that end? No, never.

(THE QUESTION.)

Will my tiny spark of being
  Wholly vanish in star deeps and heights?
Must my days be dark by reason,
  O heavens, of your boundless nights?
O rush of suns and roll of systems
  And your fiery clash of meteorites.

(THE REPLY.)

Human spirit, nearing death's dark portal,
At the limit of thy human state.
Fear not thou the hidden purpose
Of God, alone who is great,
Nor the myriads of orbs his shadows,
Nor He, the Opener of the gate.
TENNYSON.

Gentle reader, o'er creation we have been, and a little we have seen, of the radiant orbs of sky, rolling round those regions high. Now at last, through all we've passed, through this little world of ours, through the plants and flowers, we saw something of the beast, from the greatest to the least, then how you were formed, with what beauties you're adorned, then we came to mind and will, finding greater wonders still.

Now let us see, to some the greatest Mystery, how One can be Three, how can God in that way be, Three in One, Father, Spirit and Son. What a wonder! it seems to tear asunder, reason's every law, a thing like that we never saw. We cannot completely sound its deep, but only take a little peep, for our mind finite cannot grasp the infinite. All things He made are but a shadow and a shade, rising up from grade to grade, created image of His wonders boundless, for He could not make any creature, that would not have some feature, that would not typify His endless glories in the sky.

Having measureless, infinite perfections in Himself, God could not give a creature any quality or perfection He has not boundless in Himself, otherwise that creature would in this way be more perfect than the Eternal. Therefore as we see God during this life, not directly as he is, face to face, but only indirectly through the wonders of the universe, we must take creatures, see their perfections, and from them rise to the eternal uncreated perfections of their Creator.

Let us look at the original human family, image of God. Jehovah Elohim, says the original Hebrew, the Word who was God says John, made a man of earth,

breathed into him a living soul. This Divine Being, known now as Christ, made this first man, called him Adam, "Mankind." He himself was to take this very human nature, uniting in Him all Elohim had made before, to which the Spirit gave movement, for He, the Eternal Son, was to raise all the universe in that little universe, man, up to the throne of the Eternal.

Look now at this new wonder, man in all his innocence, a living temple in which God dwelled in most close companionship, worshipping his Creator in knowledge and love. But man or angel in thinking, bringing forth thoughts, could not fully image the Divine Family of the Trinity, for human thought is not a person, but an image in the mind. To bring forth another person, another man must take part. For God the Father alone cannot bring forth the Holy Spirit, his Son must be likewise a principle from which that Spirit is breathed.

From Adam's side, in sleep to smother pain, comes forth another man, his helpmate in generating, bone of his bone and flesh of his flesh, of his own human substance. So stands beside him a woman, "The womb-man." There are two men, both equally members of the human race; he a male, she a female man. The moment he saw her he loved her, when she gazed on him she loved him. Their mutual love was image of the love of Father and of Son for each other. This first marriage was the type, the image as it were not only of the eternal ineffable union of the two Persons of God, but of every wedding since, or that will be.

Let us take the first family, the original type and image of every family. Father, mother, child, form an earthly trinity. Adam was made, not born, he imaged the Father in heaven coming from no one. Eve made out of Adam typified the Almighty Son the Eternal Father generates. The first child born of Adam and Eve represented the Holy Spirit proceeding from both Father and Son.

Adam, Eve, and their first child were three separate persons, the two last descended from Adam. They

were three in one, that is three persons in one human nature. They belonged to and were individuals of the one human race. In place of Adam put the Father in heaven, in place of Eve imagine the Son who is born of the Father, in place of the child born of Adam and Eve think of the Holy Spirit, and in place of mankind put the eternal Holy Spirit, and in place of mankind put the eternal Race or the divine nature of God. In Adam's family were three separate individuals—father, mother, child, belonging to the one human race. This human race was not anything separate from these three human persons. In God there are three individuals—Father, Son and Holy Ghost, they belong to that Race we call God. This infinite Race is not anything separate from these three divine Persons. How could Adam, his wife and child be three in one? because they belonged to the one humanity. How can Father, Son and Spirit be Three in One? because they are three Individuals or Persons belonging to that One Godhead or Race or infinite species. As mankind was then formed of three persons, having one common human nature, so God is of three Persons having a common divine Nature. But the three Persons in God have the selfsame Nature, one, undivided and indivisible; and so the three Persons are but one God. On the other hand the three persons of the human race have only the same kind of nature; each has his own nature separate from the others; and so three persons of the human race are three men.

To make it clearer let us see what is a person, and what a race. The Century Dictionary says "A person is a self-conscious being," Boethius and Aquinas say, "A person is an individual substance of a reasoning nature," substance here meaning an individual or anything which exists alone of itself, as a mineral, a tree, a man or an angel, not color movement, etc., which exist in something colored or moved.

An individual is a thing existing alone, as a stone,

orb, plant or animal. But an individual of a reasonable nature, race or species is called a person. A person must be an individual of a reasoning nature separate from all others, have mind and free will, be master of his acts and responsible for them. Thus each man, woman, child or angel is a person, the three first being individuals of the human race while each angel is a race or species in himself, for angels do not marry and do not give birth to other persons like themselves.

A race or species in creatures is the nature or plan according to which the individuals are made and each individual follows its species. Thus, plants, animals, and man bring forth individuals similar to the parents, never a mixture of other species; man and woman, being two men, bring forth a man, never an animal. God, who gives creatures the power of generating others like themselves, must also bring forth, or he would not have the power of generating, and in that He would be less perfect than plants, animals and man —would not be infinitely perfect, would not be God. Each member of the human race is a person, with generative powers. God must be also a Person with generative power, or man would have what God has not, the perfection of generating, bringing forth others like Himself. In the powerful reasoning of Aquinas:

"A being that is the first mover in the universe, the first efficient cause in the series of causes, the one necessary self-existence required to explain the transit of other beings from the state of possibility to that of action, the one infinitely perfect being, according to which we measure truth, goodness and beauty of all created things, finally a being that is the governor and preserver of the universe, its lawmaker and guide, directing all secondary causes to their end, must be a self-conscious being, an individual substance having mind and free will, master of his own acts, responsible for them and consequently a Person."

To hold the universe is God, that He is the force in matter, that the world and the Deity are one and identical, is the same as to say rocks, planets, suns, light, heat and electricity are gods to whom we pray. But this is the pantheism of Haeckel, Spencer, Spinoza, of materialists, and of some scientists of our day; none but a fool would hold such a doctrine.

God is One Infinity, in that all agree, for there could not be two Infinites, for both together would be greater than one Infinite alone; that which is Infinite cannot be greater. God is not a simple unity, without contents, or internal relations, for then He would be a mere abstraction of our mind, an emptiness. He is not an idea, or thought in human minds, but a real living Being, who was before He made any angel or man to reason and know Him. He is One, not with the idea that there are others like Him, but he is One Godhead alone, and there are no other gods but He. He is the Universal, all-embracing, all-sufficing Unity, in "Whom all things live, and move, and have their being," and not in any pantheistic sense, which is only an abstraction of the mind. He is a real, complete, independent, self-sufficing, infinite, living Being, including in Himself the principles of unity and multiplicity, of identity and diversity. For these are seen in nature, image of God, and how could they be here unless they were in Him, the great original Archetype of creation? If God were simply One, a Unity without internal relations, He would be without life. He is not a dead but an ever-living God.

How beautiful is the world! What is beauty but the result of order, and how can order be without many things? Where order reigns it rules two or more things, for beauty is in the relations of these to one another. Beauty in creation must have had infinite Beauty it images. But that original Beauty is not in nature, for it was before anything was made; the beauty of the universe is but a faint, shadowy copy of God's infinite loveliness. The origin of beauty must

be sought in the interior life of the Eternal—that is, in the relations which exist in His own Being.

What is the true? The truths of mathematics appeal to minds, figures rule the heavens and the earth, all nature is founded on and regulated by figures. Who gave nature these laws? we find them here, and there, and everywhere. They came from a mind, for only minds can see and learn figures, they must have existence before creation in the Mind of an infinitely wise Being.

What is the good?

All things are good, though we don't always see their use, for everything made was good. We have an idea of goodness, we talk of good and bad people, we rise to the universal idea or thought of goodness. Where was this goodness but in God before the world was?

What are Beauty, Truth and Goodness in God but three different qualities. They are not simple abstract ideas in Him, for then they would be imperfect, and nothing imperfect can be in the Deity. They must have infinite perfection in every way, and personality. Beauty must be a Person, that is the Father, Truth must be a Person, that is the Son, Goodness must be a Person, that is the Holy Spirit.

Organisms on earth live, life is better than death; a living being is higher than a dead one and man is more perfect than stick or stone. God must live, or He would be deprived of the perfection of life. Life is movement from within, therefore God moves within Himself. What lives is active, and God's life consists in His activity moving within Himself. To say God lives is to say He acts, for when a thing cannot act it is dead. Life is movement, and movement must have a term, end, or goal to which the living being aspires. We move to produce something. Every living being moves itself.

The first man and wife received the blessing of wedlock, "increase and multiply," and since that men

and women marry, live in mutual love and friendship, find the purest joys of life in their own companionship, pleasure, peace and rest with each other, and bring forth another person like themselves. But man and wife are not ever bringing forth children, carnal generation is in this way imperfect. Man has a mind always active, while awake he is always thinking, bringing forth thoughts, ideas—children of his mind; every moment he conceives and brings forth his mental children—thoughts from his intellect, and this is the greatest joy of life. To conceive and give birth to good thoughts, to read, converse, teach, write is a pure spiritual pleasure, for this is an act of man's pure spiritual mind, highest power of human soul.

God, ever living, ever thinking, now and forever, brings forth his Thought, his Son. Forever He embraces his Son with Love overpowering, infinite, unmeasured by created minds. By and with this one act of the divine nature, the Father gives birth to his eternal Thought in thinking. Ever and forever he loves His Thought, Child eternal of His mind, His mental Word, Image of all that is in Him. He loves His Son with a Love all-embracing, finding a pleasure unsoundable, unmeasurable and infinite in generating his Son, as you find pleasure pure and spiritual in bringing forth your thoughts. This Love mutual, of Father for His Son, and of Son for His Father, is equal to them in all ways, and therefore must be a Person divine, like unto the two other Persons of the Deity. Here is the interior, eternal life of God.

Fertility is the law of life—every living being has the power of fertility, of fecundity, by which it brings forth another being like itself. Plants, animals and men generate other members of their species, the young of their race. God lives, He must have fertility and fecundity, or He is less perfect than creatures to which he gave fertility and fecundity. A man becomes a father, a woman becomes a mother. Do you think Fatherhood is not in God? He would not have

Fatherhood if he were only one Person, and would have given creatures what He did not have. Because the Almighty lives, is a divine Person, he must have the power of generating other divine Persons. Fatherhood and motherhood bring forth children of the same race or species as the parents, therefore from the fulness of His fecundity and Fatherhood God must generate divine Persons like unto and equal to himself or be imperfect beside creatures with fatherhood and motherhood.

Man, made of body and soul, has a double power of generation, or a double fatherhood, by one he generates a child, by the other he conceives and brings forth thoughts, ideas, children of his mind. Moved by instinct, love and heavenly blessings, man and wife bring forth children. So in that high, pure, eternal Trinity, that Family of heaven, of which every human family is an image, the Father, thinking, brings forth the Son, and in the eternal pure, spiritual, everlasting embrace of Father and Son, of which generation in creatures is but a weak image, from Father and Son is now and forever proceeding their mutual Love, the Holy Spirit. Fatherhood, motherhood, conception of thoughts, the birth of creatures, typify and shadow forth the high, pure, spiritual, eternal relations of these Three Persons of the Trinity.

How could the Almighty give His creatures any power or perfection he has not? Plants, animals, man, bring forth others like themselves because they live. To give rise to seeds and plants, to give birth to little animals, to bring forth their children, to bring forth thoughts, are the highest acts of life, and this too must be in God; that is the perfection of fecundity. But living organisms bring forth according to their species, their races; the young grow to be like their parents. God must bring forth other Individuals like Himself, infinite, eternal Persons similar to Him.

These Individuals, Son and Holy Spirit, He brings forth must be like unto Him, Persons of his own eternal Race or Godhead, like unto the Father equally God.

We cannot think of God except as living, to live is to act; we cannot think of Him without acting, for not to act is to be a potential, slumbering Deity; this would be only a dream of materialists, who believe in nothing but matter, who suppose the Eternal only a force in nature like weight, light, electricity, etc.

God's life is not made up of a series of acts one after the other, like movements of created living beings, but his whole life is but one infinite and eternal act, which is to live in eternity, in the ever-present NOW, for with God there is no past or future. Time is the measure of the duration of material things, mind lives in the present. Before the creation there was no time, only the ever-present of God. Let us now approach this infinite, unfathomable life of God within Himself. We will not be able to fully understand it, for no created mind can entirely grasp the Eternal.

Man's soul made to the image and likeness of God offers us the highest symbol of His life and acts. Man's reason is made up of two pure spiritual powers —reason and free will. God not only lives and acts, but also thinks, wills, and knows. He is infinitely self-conscious. Mind when active must express itself, at least within itself, and when the mind is of an infinite race, or species, it must have an infinite expression. The divine will must seek the Good, and that Good must be also infinite, for the good in creatures never satisfies human desire, and surely could not satisfy God's desire of eternal goodness. God who thinks brings forth a Thought, that Thought is the Son, and the Good coming forth from His will is the Holy Spirit.

In man or angel, intellect and will are powers of a

creature and they are limited, in God intellect and will are infinite and boundless.

God lives infinite intelligent life, His intellect ever acts, He never ceases to think, in Him intellect and will are boundless, infinite. In the logical order, intellect of angel and of man acts before the will, for it is the light of the will. We look and see the truth and love it because of its beauty and perfection. But this is not so in God, with whom all is the present—there is not a priority of time with Him, for time is the measure of the duration of matter, and in God there is nothing material—still the logical order is followed in God's mode of thinking.

With His own infinite mind God sees Himself, thinks of Himself; to think is to bring forth a thought or idea. Thinking man and angel bring forth one thought after another, for they are created thinking beings, their thoughts are not persons. But in thinking God brings forth, not many thoughts one after another, but one Thought, an Image of Himself; that must be a perfect Image equal to Him in all degrees. When we think of a man, the image in our mind is not a man, does not live like a man, is not a human person.

In God can be no weak imperfect Image, it must have every perfection of the thinking Father, or a weak imperfect Thought would be in the Deity. The Father's Thought must be just like the Father, living within Him, and be a divine Person like him. That Thought is the eternal Son, Child of his mind conceived of his mind, brought forth from his mind. The Father, seeing His eternal Image of Him, in eternity born of Him, a perfect Person like unto him, with all the infinite perfections of the Godhead, the Father loves his Son, as we love our thoughts the children of our mind. The Son, also a Person, sees the Father with all the perfections of the Deity, and loves Him as the human child loves his father. Thus from both Father's and

Son's will comes forth Love eternal. This love must be in all ways and degrees like and equal to both Father and Son, and therefore is a divine Person. This Love is the Holy Spirit, eternal Love of God proceeding, breathed forth, from God the Father and God the Son now, always and forever.

Generation, therefore, in living organism is an image of the generation eternal in God. Will He be deprived of generating powers he gave His creatures? "Shall not I that make others to bring forth children, myself bring forth, saith the Lord, shall I, that give generation to others, be barren? said the Lord thy God." Isaias lxvi. 9.

Perhaps it is not yet clear, for here we are in the fathomless deeps of the Deity in his interior life. Let us go over it again. God being a living, intelligent Being, His first act is to think, yet His thought is not multiplex; He has not many thoughts coming one after the other like ours, born to die, and dying to be born again. With limited weak minds we must bring forth one thought after another, they perish, because other thoughts press in after them, and we cannot give attention to them all at once; the second dethrones the first, a third thought takes the place of the second, thus we pass from one to other thoughts, mingling and comparing them.

But, God's intellect whose act is eternal, whose capacity is boundless, begets, conceives, brings forth all at once, a Thought equal to itself, vast as itself, imaging itself, full, complete, eternal, infinite as itself, and there is no need of a second thought, for the first has exhausted all that can be known in the abyss of the Infinite. That one absolute Thought first-born, and last born, and only born, forever remains in his presence, in his mind, a full, exact, complete Image of the Godhead, "Being the Splendor of his glory, and the Figure of his substance." Heb. i. 3.

When we think, we bring forth mental words, thoughts, thus we talk to ourselves. We express them by words of different languages, but the thoughts remain within our mind. In God the Thought forever remains with His mind. Child of His mind, conceived, born, brought forth in his mind, the Thought, Idea must be God's equal in all ways and degrees, and must be a Person like to the Father. This is what John means when he says: "In the beginning was the Word, and the Word was with God, and the Word was God." John, i. 1.

This is the mental word of God, as our thought is the mental word of our mind. But this Word of God differs from ours in this, that with this one Word, one Thought, God says all that can be said in one utterance, spoken eternally, from everlasting, without ever repeating. We speak in many words, we think many thoughts, while God speaks all with one Word—that is His Son. In the original Hebrew of the Old Testament, the Word of God, the eternal Son, is first called Jehovah: "He who is," in other places he is named Memra, "Wisdom," the Greeks called the Son Logos, "Learning," Sophia, "Wisdom." The Word Divine of the Eternal Mind is the Learning, Knowledge of God. The wisdom, learning, laws, mathematics of the universe are expressions of the Son, this wondrous Wisdom creating, forming, law-giving and governing nature. "All things were made by him, and without him was nothing made that was made." John i. 3.

In man his thought differs from his mind, ever exists within his mind, can never be separated from his mind. so God's Thought, the Son, remains within His eternal mind which gives It birth. Thought in human mind is spiritual like unto the spirit mind which conceives and brings it forth, so the Word of God the Son must

be of the same nature as the Father's mind which generates Him. Though the Son is a Person different from the Father, He must be of the same divine nature as the Father, as child is of the same human nature with the parents. Therefore the Creed of Nice defined the Son as being "consubstantial with the Father," that is, of the same divine nature, of the same eternal Race with the Father, for beings must bring forth others of their nature, or race. Our thought, or idea, is different from our mind, is the image of what we think, but it is not a person. But this imperfection is not in God, for in His mind, the Thought is a Person, infinite, like the thinking Father, who brings Him forth as an Individual or Member belonging to the nature or eternal Race we call the Deity.

Here is a Person called the Father, who thinking brings forth another Person, the Son, a Subsistence, a Person never separating from the divine essence, never leaving the circle of the Divine Life, never quitting the bosom of the Father, remaining within the Deity's mind, finding there all infinite that can be, wanting nothing to finish, perfect, the Godlike way of living.

Unity and plurality never finish themselves in us; we cannot live in ourselves alone and for ourselves alone; we must seek happiness, find board and clothes, go out, seek friends, look for aids to others, learn from them, enjoy the pleasures of conversation, find new ideas. But it is not so in God, for unity and plurality, like all in Him, are perfect. He passes eternity within himself, in intimate life conversation of divine Person with divine Person. The unborn Father lives with only-begotten Son, both enjoying the Fellowship of the Holy Spirit coming from both Father and Son, the other divine Person with them. God thinks, and in that Thought he sees Himself as in another, who is so near and so dear to Him as to be only one divine nature or species with Him, as the earthly father sees his son like unto him, of the same species or human nature with him. Seeing his own Thought, his own Image

generated from his Fatherhood, He bears the relationship with him of Sonship; here is the original Fatherhood, and the original Sonship of all creatures which bring forth. To Him he says in the ecstasy of first delight of Fatherhood : "Thou art my Son, to-day I have begotten thee," Psalm ii. 7. To-day is that endless eternity, without beginning or end, belonging only to the Eternal.

But the generation of the Son is not the only act of the Deity, nor does it fill up the whole of that one great infinite act of God's internal and eternal life. Bringing forth the Son does not end, or finish His perfection of fecundity, or the happiness of God no more than in man. We not only think, but we love, and so it is in God. Thought in us is a look of the soul, an act of the mind bringing forth truth, an image in the mind. But we not only think, we also love. That love is an act of the will, which draws us out of ourselves with a movement towards whom we love, tending to unite us to our love, to what we love, and it to us. As mind must have an image, love must have an object or a person to love. We cannot always love ourself, that is selfishness.

Whatever lives loves its own kind. Animals gather together, for every beast loves its kind. Man loves the members of his race. What an awful thing it is for a human being to have no one to love him, or no one whom he can love, to be absolutely alone in the world. We cannot enjoy a thing unless those we love enjoy it with us. It is man's nature to love a woman, and woman's to love a man. This deep instinct of nature ends in marriage, than which nothing in nature is more beautiful, which is completed, finished in the children they bring forth. The wife and husband with their children overflow with love for each other.

What is love? Poets, novelists fill books with stories of love, love moves the universe, is an instinct directing creatures toward their end. Beauty, truth, harmony, perfection, inspire love; the deformed, the

false, the defective repel love. Will creatures love and God not love? God is love infinite, for He is Beauty, Truth, Perfection boundless and infinite. Let us see how God loves.

The Eternal Father thinking brings forth His Thought—His Son, the perfect Image of His own boundless Beauty, Truth, Perfection, and loves Him with a boundless all-absorbing love. The Son, a Person equal to his Father, looks on his Father and loves Him with an equal boundless infinite perfect love. Take the love of husband for his wife, of wife for husband, imagine, if you can, two persons of an infinite race, that they are almighty—like to the Persons of God, magnify that love to be infinite, boundless, eternal in all ways, and you may have a faint idea of the eternal love of Father for Son, and of Son for Father. Down come now to earth, see the family; result and product of the love of man and wife is the child born of both.

Now rise again to the Eternal Persons, the Family of the Trinity. The Father, seeing Beauty, eternal and exhaustless in the perfections of his Son, loves him with a love unthinkable to mankind, and with an equal affection the Son must love his Father. Here is a mystery of unity in plurality. From each of these two Persons comes one and the same love, proceeding, not from their one mind common to them both, but from their common will, another act of the divine intelligence, for while the thought, truth, is in created mind, love or affection is in the will of all intelligent beings God made. Thus God thinks with his own being and not by mind or will powers.

This love of Father for His Son, of Son for His Father, cannot be a simple sentiment, an act of the will imperfect as in creatures, but must be infinite in every degree, equal to these two Persons from whom it proceeds, must be a Person like them or the imperfect would be in the very nature of the Eternal. Love

then is the Holy Spirit, breathed from both the other Persons. The Holy Ghost, Love of Father and of Son, mutual to both, having the same divine nature as both, coming from the will of both from the thinking which is an act of the Divine mind, and from the Thought or Son, without which mind could not think, the object that will loves, remains one with both Thought and Mind in the self-same life-circle of the ever-living Godhead.

We said the eternal Thought, or Idea called the Son, rises in the thinking mind of the Almighty, that the Holy Spirit is breathed from the will of God, but this is not exactly so. In men and angels, mind and will are powers, or faculties of the soul, and animals and plants act through their organs animated by faculties of their living principles.

But God has no mind or will different from His own divine nature, or essence of the Godhead. For if He had mind and will, faculties differing from His essence, powers through which He acts, mind and will would be two other Persons, and there would be five Persons in God, for everything in Him must be infinitely perfect and have personality. Mind and will in God are God Himself thinking and willing. Mind and will making intellectual nature in man and angel, created intelligence, image, in a feeble way, the uncreated intelligence of God. The Almighty acts with infinite perfection, thinking and loving by His very nature itself, not by any power of mind and will. His intelligence, learning, logic, knowledge, wisdom, eternal principles, mathematics, pure truths—all the Eternal grasps are in His Son, Archetype, original Source of all that is true. His love, affection, dearest thought, fondness, aspirations, delectations are ever in his Holy Spirit, ever and forever proceeding from Him and from His Son.

Thus in the ever NOW, not in past or future, from that look of love between both, from that co-eternal regard of both, interchanged between Father and Son, is born a third Term of relationship, a third Person,

like both, coming forth from both, different and distinct from both, having His origin in both, product of the Deity of both, originating in the Godhead of both, equal to them both, infinite as both, belonging to the same Eternal Race or species as both.

Thus as the Son comes from the Father thinking, the Holy Spirit comes from both Father and Son in loving each other. In God, mind, intellect, is filled, satisfied by the generation of His infinite Thought the Son, so his boundless love, affection, fondness for His Son, and of His Son for His Father, in His will are filled, finished, satiated in His Love the Holy Ghost, measureless, pauseless movement of divine Love. Thus ever and forever God's hidden life fills, finishes, completes the eternal cycle of His life's activity. His Fatherhood, His Sonship, His Spiration filling the fecundity of His eternal, ceaseless, unbeginning and unending life. There is original infinite life, with generation eternal, the heavenly Family, the Archetype, the Eternal to which every creature is made as a weak, imperfect image.

Only three Individuals or Persons belong to that infinite eternal Race, God. He is three Persons in one infinite species or Race. To be only one Person, he would have to be deprived of thinking and of loving. To think He must bring forth His Son, to love He must bring forth his Spirit. God therefore could not be other than Three in One. or he would cease to be.

THE END.

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